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OF NEW YORK

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No. 1

INTRACRANIAL ARTERIO-VEINOS ANEURISM OR PULSATING EXOPHTHALMOS

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SINCE 1809, when the phenomena of pulsating exophthalmos was first described, until June of 1923, there have been 588 instances of this malady recorded in the literature. This includes the 106 cases up to 1880 collected by Sattler,¹ the 138 cases of the combined series of Keller,² 1898, and Reuchlin,³ 1902, the 69 of de Schweinitz and Holloway,⁴ 1907, the 88 cases of the combined series of Bedell,⁵ 1915, Rhodes,⁶ 1916, Zentmeyer,⁷ 1916, and Von Nagy,⁸ 1919, and the 131 cases collected by the author. The purpose of this paper is to gain information concerning the etiology and pathology of pulsating exophthalmos by the analyses of the entire series and especially to study the question of treatment, for thus far the therapeutic results have been quite unsatisfactory. An attempt will also be made to explain the various clinical phenomena associated with this disorder and three cases of the author's own experience will be reported in some detail.

HISTORICAL

Pulsating exophthalmos was first described in 1809 by Benjamin Travers,⁹ demonstrator of Anatomy at Guy's Hospital. He had no post-mortem evidence on which to base his conclusions, but believed the condition was confined entirely to the eye and its etiology was that of "Aneurism by Anastomosis" or cirroid aneurism of the orbit. Travers found that compression of the common carotid artery of his patient caused the bruit to stop and the exophthalmos to decrease and he therefore instituted the surgical treatment of ligation of the common carotid. Thus he was not only the first to describe the condition, but was the first to describe its surgical treatment even in the days before the discovery of anaesthesia. (See Fig. 1, a reproduction of engraving from Travers' original article).

Three years later, in 1812, Dalrymple¹⁰ reported the second case of pulsating exophthalmos and accepted Travers' idea concerning its etiology, and as did the subsequent writers up to 1823. However, in this year, Guthrie¹¹ performed the first autopsy on one of these cases and instead of finding a cirroid aneurism as had been supposed, he found a nut-size aneurism of the ophthalmic artery and thus he advocated this as the etiology of all previously reported cases of pulsating exophthalmos. In 1837, Warren¹² of Boston reported the first case of pulsating exophthalmos following trauma. When in 1839, Busk¹³ confirmed Guthrie's findings by autopsy of another case, it soon became accepted, at least in England, that aneurism of the ophthalmic artery was the cause of this clinical complex. However, in France in 1835, even four years before

Busk's report, Baron¹⁴ purposed a new etiology, being the first to discover at autopsy a communication between the cavernous sinus and the internal carotid, and thus established the fact that the cause of pulsating exophthalmos might be an intracranial rather than an extracranial disorder. So brief was his report, however, that it escaped general

notice, yet he should have the credit of establishing the most important point in the etiology of pulsating exophthalmos. In 1841, Gendrin¹⁵ reported an autopsy upon a case of pulsating exophthalmos and found as did Baron a communication between the internal carotid and cavernous sinus. Nélaton,¹⁶ in 1856, found another such communication at autopsy, and in 1857, the following year, Hirschfeld,¹⁷ also in France by another autopsy report confirmed the idea of an arterio-venous communication.

Brainard,¹⁸ Professor of Surgery at Rush Medical School, in 1851, cured a case of pulsating exophthalmos by injection of a coagulating fluid into the dilated veins about the orbit, yet the patient lost the vision in that eye. In 1856, digital compression was first recommended and used successfully by Professor Gioppi,¹⁹ of Padua, Italy, for treatment of a case of spontaneous pulsating exophthalmos, and in 1857, bilateral ligation of the carotid was used by Buck,²⁰ of New York.

In 1870, Delens²¹ of Paris, published an exhaustive monograph on arterio-venous communication between the cavernous sinus and the internal carotid. Although French writers after 1835 recognized the intracranial origin of most cases of pulsating exophthalmos, the English continued to attempt to explain the condition on a purely orbital basis. Thus in 1854, Curling,²² of London, supported the view of Busk concerning the etiology and in 1858, Bowman and Hulke,²³ of London, recorded a case with autopsy in which they found a dilated ophthalmic vein but no intracranial lesion.

In 1859, Nunneley,²⁴ Chief Surgeon of Leeds Eye and Ear Infirmary, thought the etiology was a false traumatic aneurism of the eye, or less often an aneurism of the ophthalmic artery. Nunneley's next paper in 1864, brought the first admission



FIG. 1.—Engraving of Travers' patient before and after operation, from *Med. Chir. Trans.* 1813, vol. ii. This was the first description of pulsating exophthalmos.

by English authors that the condition might be of intracranial origin. He gave up his former idea of false aneurism and believed that an obstruction to the return flow from the eye through the ophthalmic vein to the cavernous sinus was to be held accountable.

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This obstruction he suggested might be a collection of serum, fibrin, pus, or a tumor. The spontaneous cases he thought were usually aneurisms of the internal carotid or of the ophthalmic artery immediately after its origin.

In 1853, the first case reported which subsided spontaneously without digital compression or ligation was described by France²⁷ of Guy's Hospital and in 1874, Lansdown,²⁸ Surgeon at Bristol General Hospital, cured a traumatic case by ligation of the varicose vessels at the inner canthus of the eye, this being the first recorded case cured by an orbital operation.

In 1875, Rivington's,²⁷ London, notable paper on "Pulsating Tumor of the Orbit"

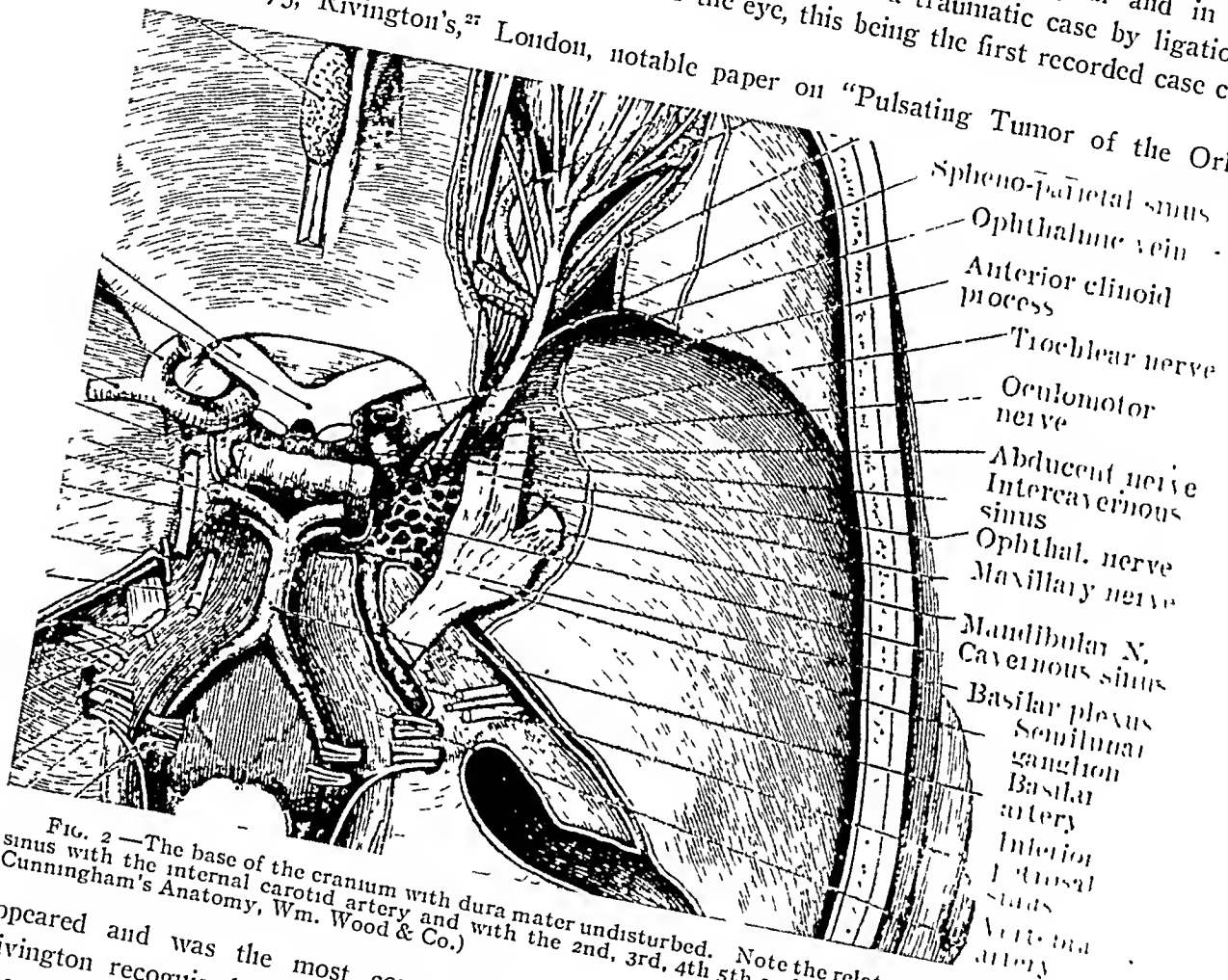


FIG. 2 —The base of the cranium with dura mater undisturbed. Note the relation of the cavernous sinus with the internal carotid artery and with the 2nd, 3rd, 4th 5th and 6th cranial nerves. (From Cunningham's Anatomy, Wm. Wood & Co.)

appeared and was the most comprehensive work on the subject up to that time. Rivington recognized arterio-venous communication as the etiology of most cases, but also mentions aneurism of the ophthalmic artery and morbid conditions of the orbital veins and intracranial sinuses.

Sattler,¹ Berlin, in 1880 collected 106 cases which was a complete list of the reports in the literature up to this date. He too believed that the etiology of most cases was an arterio-venous communication and that in previously reported autopsies this communication had been frequently overlooked.

Similarly, Keller,² in 1898, and Reuchlin,³ in 1902, discussed in inaugural dissertations in Germany the etiology of pulsating exophthalmos and collected additional cases from the literature.

Murray,²⁸ New York, in 1904 first ligated the internal carotid in treating pulsating exophthalmos and had successful results.

The next large study of the subject was made by de Schweinitz and Holloway,⁴ Philadelphia, in 1907. They assembled information from all previously reported cases, making a total of 313 and their figures showed that although a communication between the internal carotid and cavernous sinus was the most frequent cause, yet a certain

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number of cases were due to an aneurism of the ophthalmic or the internal carotid artery, or to tumor of the orbit.

Since this most memorable monograph by de Schweinitz and Holloway numerous

TABLE I.
Showing Proportion of Males and Females.

Etiology	Number of cases collected	Number of males	Per cent. males	Number of females	Per cent. females	Sex not stated
<i>Spontaneous</i>						
Author's series (1923)	38	6	18.18	27	81.82	5
Combined series of Bedell (1915); Rhodes (1916); Zentmeyer (1916); and Von Nagy (1919).....	17	6	37.5	10	62.5	1
De Schweinitz and Holloway series (1907)	14	6	42.85	8	57.14	0
Combination of all series preceding 1907 including Rivington's, Sattler's, Keller's, Reuchlin's, etc., series.....	57	12	23.64	41	77.35	4
Total spontaneous cases.....	126	30	25.87	86	74.13	10
<i>Traumatic</i>						
Author's series	83	60	84.51	11	15.49	12
Combined series of Bedell (1915); Rhodes (1916); Zentmeyer (1916); and Von Nagy (1919).....	67	56	86.15	9	13.84	2
De Schweinitz and Holloway series (1907)	54	31	65.95	16	34.04	7
Combination of all series preceding 1907....	214	147	73.5	53	26.5	14
Total traumatic cases.....	418	294	76.76	89	23.24	35
<i>Etiology Not Stated</i>						
Author's series	10	6		0		4
Combined series of Bedell (1915); Rhodes (1916); Zentmeyer (1916) and Von Nagy (1919).....	4	1		0		3
De Schweinitz and Holloway series (1907) ..	1	0		0		1
Combination of all series preceding 1907....	29	0		0		29
Total.....	44	7		0		37
Grand total all cases	588	331	65.42	175	34.58	82

case reports have appeared, yet no complete assembly of them has been made and hence no conclusions have been drawn.

Etiology.— (See Table I.) Of the entire series of 588 cases, there have

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been 544 cases in which the etiology was stated. Of these, 126, or 23.16 per cent., were spontaneous and 418, or 76.84 per cent., were traumatic in origin. In the series of cases collected by the author the percentage of spontaneous origin was somewhat higher for out of 121 cases in which the etiology was stated, 38, or 31.40 per cent., were spontaneous, and 83, or 68.60 per cent., were traumatic in origin. By reference to Table I, it will be seen that in the spontaneous type the female predominates and in the traumatic type the

TABLE II.
Age in Pulsating Exophthalmos.

<i>Cases of Spontaneous Origin.</i>				
Ages	Author's series	Combined series of Bedell, Rhodes, Zentmeyer and Von Nagy	Series of De Schweinitz and Holloway	Total
1-10	1	0	1	2
11-20	2	2	0	4
21-30	4	3	3	10
31-40	4	0	4	8
41-50	4	3	0	7
51-60	8	2	2	12
61-70	3	1	1	5
71-80	5	3	1	9
81-90	0	1	0	1
Age not stated	7	2	2	11
Total.....	38	17	14	69
<i>Cases of Traumatic Origin</i>				
1-10	0	0	7	7
11-20	18	6	5	29
21-30	16	13	12	41
31-40	13	12	5	30
41-50	9	9	9	27
51-60	5	3	6	14
61-70	1	1	0	2
71-80	0	0	0	0
81-90	0	0	0	0
Age not stated	21	0	10	54
Total.....	83	67	54	204

male predominates. Thus, of the former type we find 74.13 per cent. women and of the latter type 76.76 per cent. men. Of the author's series 81.82 per cent. of the spontaneous cases occurred in women and 84.51 per cent. of the traumatic cases were in men.

As may be seen from Table II, the average age of the spontaneous type is greater than that of the traumatic type. Thus the average age of the spontaneous cases included in this table is near the end of the fifth decade while the average age of the traumatic cases is near the end of the third decade. The average ages in the author's series were forty-eight years for the spontaneous type and thirty-two years for the traumatic.

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The left eye is involved more often in the spontaneous type while the right eye is slightly more frequently involved in the traumatic type. The

TABLE III.
Showing Proportion of Involvement of Right or Left Eye.

Etiology	Involving	Author's series	Combined series of Bedell, Rhodes, Zentmeyer and Von Nagy	De Schweinitz and Holloway series	Combined Sattler, Reuehlin and Keller	Totals	Percentages
Spontaneous..	Right Eye	8	8	4	22	42	33.33
	Left Eye	18	4	6	30	58	46.03
	Both Eyes	6	2	2	2	12	9.53
	Not Stated	6	3	2	3	14	11.11
	Total	38	17	14	57	126	
Traumatic....	Right Eye	28	30	25	82	165	39.47
	Left Eye	25	24	21	87	157	37.56
	Both Eyes	14	8	5	31	58	13.88
	Not Stated	16	5	3	14	38	9.09
	Total	83	67	54	214	418	
Etiology not Stated.....	Right Eye	0	1	1	0	2	
	Left Eye	0	0	0	0	—	
	Both Eyes	0	0	0	0	—	
	Not Stated	10	3	0	29	42	
	Total	10	4	1	29	44	

TABLE IV.
Table of Autopsy Finding in Pulsating Exophthalmos.

Lesion	Spontaneous		Traumatic		Total
	Autopsies collected by author	All previous reported autopsies *	Autopsies collected by author	All previous reported autopsies *	
Arterio-venous communication.....	3	7	4	10	24
Thrombosis of cav. sinus and ophth. vein with probable art.-ven. communication.....	0	6	0	2	8
Aneurism of int. carotid.....	1	2	0	1	4
Aneurism of ophth. artery					
Within orbit.....	0	2	0	0	
Outside orbit.....	0	1			3
Tumors of orbit.....	1	6	0	0	7
Lesion not discovered.....	1†	3†	0	0	4
Total.....	6	27	4	13	50

* Includes 19 autopsies collected by Sattler; 9 by Keller; 2 by Reuehlin; and 11 by De Schweinitz and Holloway.

† Two of these 3 were patients in whom the pulsating exophthalmos had been cured and patients died of other cause.

‡ Incomplete autopsy.

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figures may be seen in Table III. A bilateral pulsating exophthalmos occurs more frequently in the traumatic group than in the spontaneous group. *Pathology.*—Up to 1907 (de Schweinitz and Holloway), there were 40 autopsies upon cases of pulsating exophthalmos recorded in the literature. Since that time the author has been able to add 10 to this number, making a total of 50 post-mortem examinations. See Table IV. Of this number, 33 were performed upon spontaneous and 17 upon traumatic cases. Of the 33 autopsies on spontaneous cases there were 4 in which no lesion was found. In two of these, however, the pulsating exophthalmos had been cured some time previous to death and in a third case only an incomplete examination was made. Of the 30 remaining cases there were 16, or 53.33 per cent. in which communication or a probable communication between the internal carotid and cavernous sinus was found, 7, or 23.33 per cent. in which were tumors, 3, or 10 per cent. aneurisms of the internal carotid, 3, or 10 per cent. in which no lesion was found. The findings of 17 autopsies upon traumatic cases is quite a different story, for 16, or 94.12 per cent. of these proved to be arterio-venous communication of the internal carotid and cavernous sinus, and only one case as aneurism of the internal carotid.

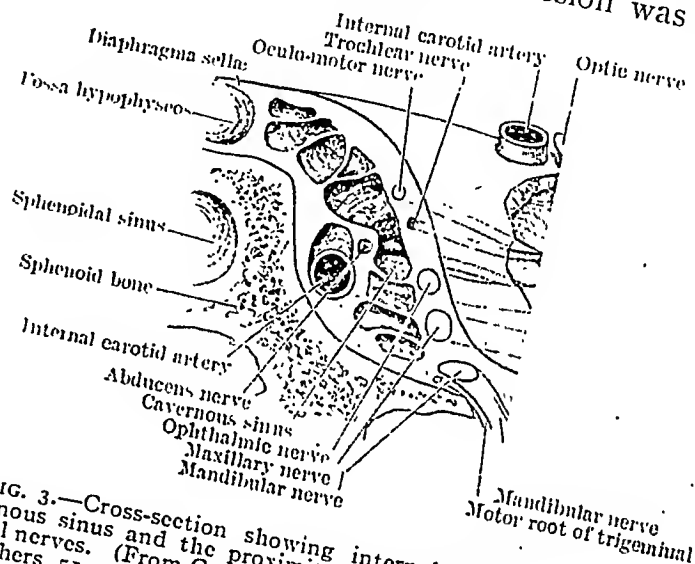


FIG. 3.—Cross-section showing internal carotid within the cavernous sinus and the proximity of the 3rd, 4th, 5th and 6th cranial nerves. (From Cunningham's Anatomy, Wm. Wood & Co., Publishers, 51-5th Avenue, New York, N. Y.)

Although arteriosclerosis has been a prominent feature in many of the spontaneous type there are very few cases in which the history suggests lues. There have been, since the time of the Bordet-Wassermann reaction, 19 cases on which this test was performed. Of this number 2 were positive and 17 negative. One of the cases with a positive reaction was a thirteen year old lad having a traumatic type and the other was a woman of seventy-eight years with a spontaneous type in which autopsy showed a tumor of the orbit. From the evidence available we would therefore conclude that lues is not a contributing factor.

In summarizing the pathology it may be stated from the scant information at hand that practically all cases of the traumatic type of pulsating exophthalmos are due to an intracranial arterio-venous communication. Of the spontaneous type only a little over one-half of the cases can be attributed to this cause, while about one-quarter are caused by tumor and another quarter by simple aneurism of either the internal carotid or ophthalmic artery.

Anatomical Considerations.—The anatomical boundaries of the cavernous sinus and the close relation to the internal carotid are clearly shown in Fig. 2 from Cunningham's Anatomy. The proximity of the 2nd, 3rd, 4th, and 6th cranial nerves, and ophthalmic division of the 5th cranial nerve to the cavernous sinus may be readily seen. A cross-section of the cavernous sinus, Fig. 3 from Grey's Anatomy, shows the internal carotid artery

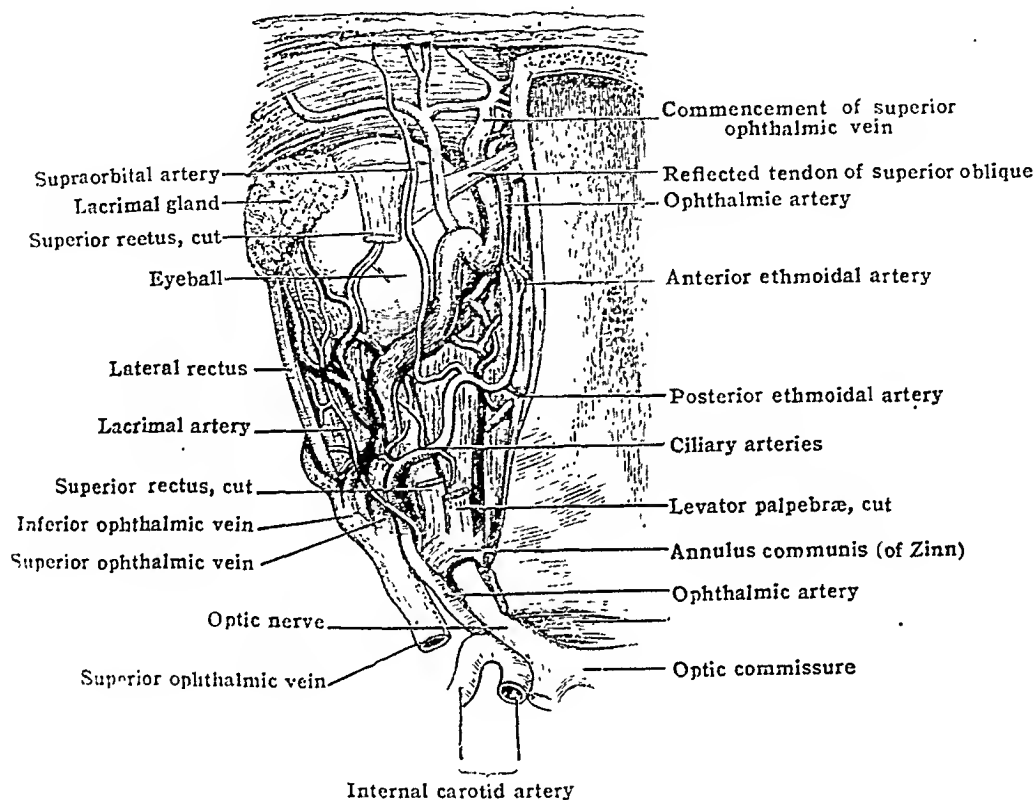


FIG. 4.—The left ophthalmic artery and vein. Note the venous plexus behind the orbit. Exophthalmos associated with intracranial arterio-venous fistula of the internal carotid and cavernous sinus may be caused by the dilatation of these pulsating vessels pushing the eye forward. (Morris' Anatomy, P. Blakiston's Son & Co.)

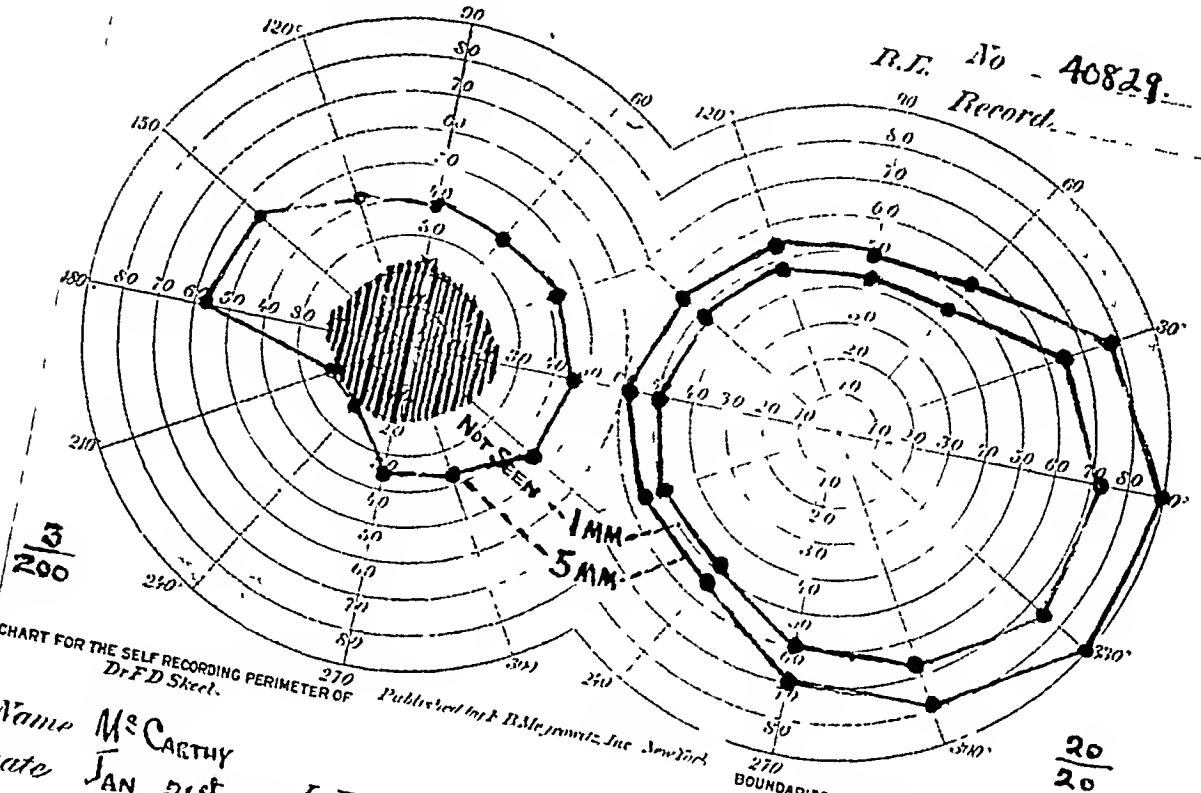
lying within the sinus with the 3rd, 4th, 6th and the ophthalmic and maxillary divisions of the 5th cranial nerve.

Rawlings²⁹ has found that 70 per cent. of the fractures of the base of the skull involve the body of the sphenoid bone. Both internal carotid artery and cavernous sinus are comparatively immovable in this region so that it is quite natural that an underlying fracture might rupture or injure their adjacent walls. The cases of actual rupture are those clinically in which the patients hear the bruit immediately upon return of consciousness, while those who hear the bruit only some days or weeks after the accident are cases in which only a damage of the vessel walls has occurred, which later ruptures. A penetrating wound, too, may have such a course that it comes in contact intracranially with both internal carotid artery and cavernous sinus. It thus may rupture or weaken the adjoining walls of these two vessels.

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Date *Apr. 20th 1923* *J.E.*

R.E. No - *40829*
Record.



Name *McCarthy*
Date *Jan 21st 1924* *J.E.*

R.E. No - *40829*
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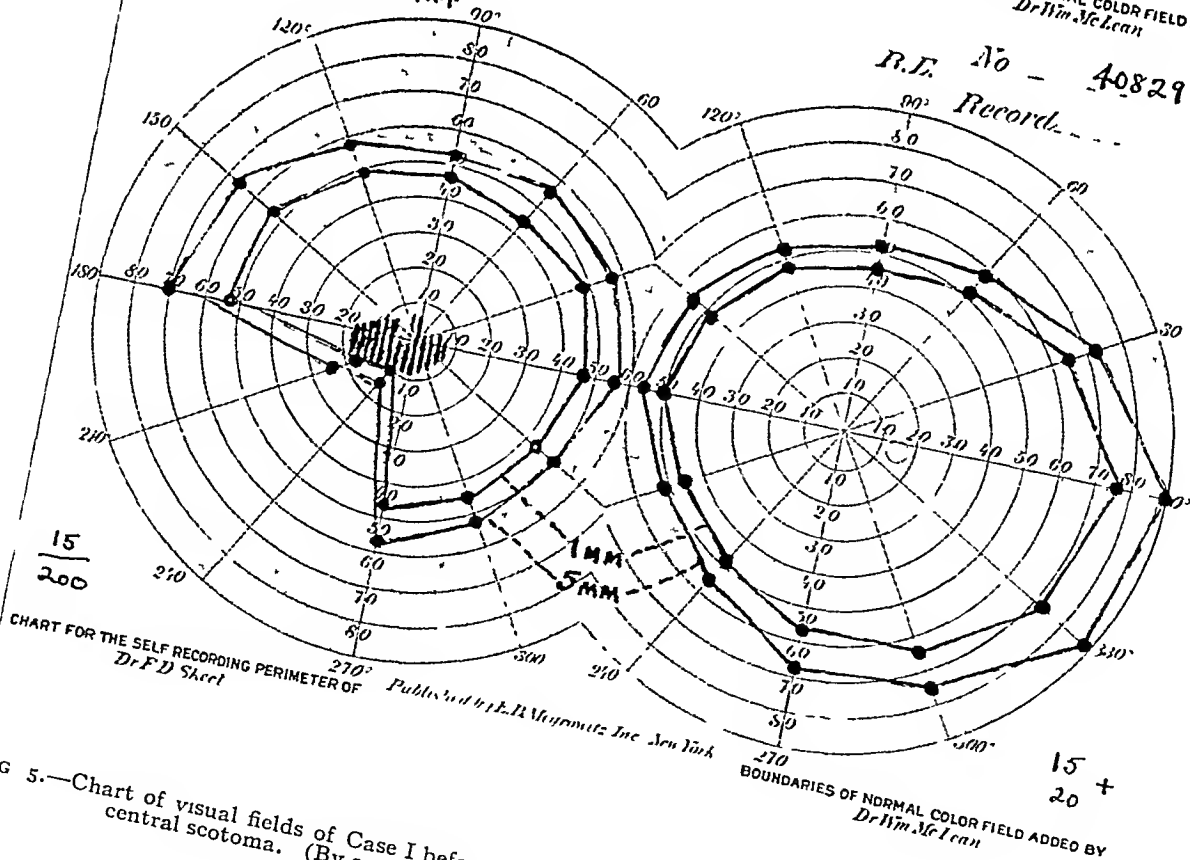


Fig 5.—Chart of visual fields of Case I before and after operation. Note the decrease in size of the central scotoma. (By courtesy of E. B. Meyerowitz Surgical Instrument Co.)

The mechanism of production of a pulsating exophthalmos spontaneously without an injury is more difficult to explain. This may be due to a diseased and weakened condition of the walls of the adjoining vessels. Again, it seems probable that an arterio-venous communication may occur by a rupture of a simple aneurism in the portion of the internal carotid which lies within the cavernous sinus or in its immediate neighborhood. The

spontaneous type of pulsating exophthalmos, of course, may be due also to a simple aneurism of the internal carotid or ophthalmic artery, or even to tumor of the orbit.

The enormously dilated and pulsating ophthalmic vein lying behind the orbit affords at least one explanation of the exophthalmos and orbital pulsation associated with the phenomena of arterio-venous communication between the internal carotid and cavernous sinus. Figure 4 of the orbital veins after Poirier and Charpy show the plexus behind the orbit, which takes part in this dilatation.

The explanation of the cause of the very large, pulsating, vascular masses above the internal angle of the eye is a question which naturally arises. One would suspect with a fistula between the internal carotid




FIG 6—Case I before operation. Note the exophthalmos and internal strabismus of left eye and the ptosis of left upper lid infringing on pupil.

and the cavernous sinus that the rush of arterial blood would be amply taken care of in the great intracranial venous sinuses. This, however, is not true, for in the majority of cases much of the arterial blood finds its way into the superior ophthalmic vein forming large dilated swellings. The anatomical explanation of this fact, I think, is that the ophthalmic veins have no dense tissues surrounding them such as the bone and dura which surround the superior and inferior petrosal sinus, the other exists of the cavernous sinus.

The various cranial nerves may be involved in four very different ways by four very different types of mechanism: First, that of direct injury of the nerve by the fracture or contusion which causes the rupture of the cavernous sinus and internal carotid. Thus the 1st, 2nd, 3rd, 4th, 5th, and 6th

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cranial nerves are often taken and less frequently the 7th and 8th. These signs are present soon after injury and perhaps are augmented by slow hemorrhage. The visual fields of Case I shown in Fig. 5 are an example of this type of injury. Secondly, cranial nerve signs may be caused by pressure from actual dilatation and hypertrophy of the vessels on either side of the arterio-venous communication. The cranial nerves affected by this mechanism are the 2nd, 3rd, 4th, 6th and the ophthalmic division of the 5th, and the signs usually appear some days or weeks after the injury. The effect of a third type of mechanism is limited to but one cranial nerve. It is due to pressure upon the supraorbital nerve near its exit from the supra-orbital foramen by the enormous pulsating dilations of the superior ophthalmic vein and its branches. Thus in the author's second case it seemed probable that this was the mechanism for the slightest touch with the finger in the region of the supraorbital foramen would often cause sharp and uncomfortable paræsthesias over the left frontal region. The fourth mechanism is limited to the 2nd nerve and is of purely circulatory nature. Thus it seems that the short circuiting of arterial supply or even venous congestion may cause optic trophy.



[FIG. 7.—Case I two weeks following ligation of left internal carotid. Note improvement in the exophthalmos, the ptosis and the internal strabismus.]

Symptoms and Signs.—The following case reports illustrate the subjective and objective findings in this rare condition of pulsating exophthalmos. Cases I and II are from the division of neurosurgery of the University of California Hospital, Case III a San Francisco Hospital patient which the former Resident Surgeon, Dr. Ray Kistler, was good enough to send to us for examination. A fourth case will be merely mentioned which was a patient at the Peter Bent Brigham Hospital on Doctor Cushing's wards, that came under my care during my service as Neurosurgical Resident.

CASE I.—Accident. Resulting Pulsating Exophthalmos. Digital Compression of Carotid No Improvement. Ligation of Internal Carotid. Marked Improvement.

University of California Hospital No. 18043, an American male, aet, twenty-five, an electrician by occupation had a negative family history except that father died aet, forty-six of apoplexy. Past history was negative. Present illness: On September 25, 1922, the patient was in an automobile accident and was unconscious for forty-eight hours, with profuse bleeding from the right ear, nose and mouth. There was no subsequent memory of the next five days, but on fully regaining his senses, he noticed numbness of the left side of the face, stopping at the midline, deafness of right ear, and with the left eye his vision was only sufficient to distinguish between light and darkness. Six weeks after accident, the patient was first aware of a blowing bruit within his head, louder on the left side, which he described as sounding like "the exhaust of a steam valve". At this time the vision in the left eye was still defective and soon



FIG. 8.—Case II before operation. Note exophthalmos, internal strabismus and ptosis.

an internal strabismus and exophthalmos of O.S. appeared. He then first noticed a bilateral loss of smell. On January 4, 1922, the patient entered University of California Hospital. At this time physical and neurological examination showed a well developed, very muscular young man with a left-sided pulsating exophthalmos (see Fig. 6), a systolic blowing bruit best heard over left eye and left temporal region, and an external rectus palsy of O. S. with internal strabismus. There was some engorgement of the small veins at the inner canthus and of the upper lid, but without distinct pulsation of them. The left pupil reacted sluggishly and there was marked ptosis on this side. Although definite subjective symptoms of numbness over the 1st and 2nd divisions of the left trigeminal were present, there were no objective signs. Hearing was diminished in the right ear, there was a bilateral loss of olfactory sense and visual acuity of O. S. was such that patient could see only the 20/100 letters when holding an ordinary acuity chart in his hand; acuity of O. D. was 20/20. Ophthalmoscopic

examination of O. S. showed a pale disc with slightly hazy outline and dilated tortuous veins; O. D. normal. Visual fields showed defect (see Fig. 5), an X-ray of skull showed a left frontal fracture. Blood-pressure was 128/95. Compression of the left common carotid stopped the bruit subjectively and objectively while compression of the temporal or facial arteries or the carotid on the opposite side had no effect. Blood Wassermann and urine were negative. *Treatment:* For about three weeks the patient was kept quiet in the hospital and digital compression applied. Due to the heavy musculature of his neck, compression could not be maintained for over 10 to 15 minutes at a time. Even a slight movement of the sterno-mastoid muscle or the act of swallowing would cause the artery to slip away from the compressing finger. The patient was then sent home where the same treatment was continued for

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eleven weeks without improvement. On May 1, under local anaesthesia the left internal carotid was exposed and compressed with a Crile clamp for thirty minutes. During this time no weakness, nor numbness of the opposite extremity developed, so a permanent double ligature was made. This shut off the bruit subjectively, but objectively it was still present, yet diminished to about one-tenth of its previous intensity and was of a very much higher pitch. During the following weeks the bruit became even more feeble and often could not be heard at all. It could be entirely shut off by compression of the opposite carotid. The exophthalmos improved remarkably, the internal strabismus largely disappeared and ptosis became less marked (see Fig. 7). The patient went back to work July 1, 1923, and reported that he had been working steadily when seen again on January 21, 1924.

At this date his appearance was the same as that shown in Fig. 7. Visual fields showed same defect in O. S. as that noted before operation. The central scotoma, however, had decreased in size and usual acuity was somewhat improved (see Fig. 5). Nevertheless, examination of the fundus O. S. showed increased distinctness of the cribriform markings. The blood-vessels appear normal. A faint bruit, barely audible, was heard over the left orbit and in the left temporal region. This is, however, not heard by the patient except occasionally at night. The defect in olfactory sense was still evident although not as well marked as previously. Auditory acuity on the affected side, the right side, was almost normal.



FIG. 9.—Case II two weeks after ligation of left internal carotid. Note improvement in exophthalmos, strabismus and ptosis.

CASE II—Accident. Pulsating Exophthalmos. Digital Compression of Carotid. No Improvement. Ligation of Internal Carotid. Improvement. Ligation of Superior Ophthalmic Vein. Further Improvement. University of California, Hospital No. 19647-A an Irish born American male, aet, forty-two, a drygoods clerk by occupation, had an insignificant family history. Past history was negative except for malaria aet thirty-five; Neisser aet eighteen; and excessive use of alcohol and tobacco. Present illness: On September 25, 1922, while intoxicated, was struck by a motor truck, was unconscious for one and one-half hours and had considerable bleeding from his nose, although for the next forty-eight hours the patient seemed conscious, he had no subsequent memory of this time. He first remembered severe left frontal and partial headaches and a blowing noise within his head. Five days after accident there was diplopia and the left eye turned inward but exophthalmos was not noted until about five weeks later. About four months after accident he first was aware of paræsthesias over ophthalmic division of the left trigeminal

nerve and he entered the University Hospital, February 6, 1923, almost four and one-half months after injury. At this date physical examination and neurological examination showed a well marked pulsating exophthalmos O. S. (see Fig. 8), a systolic bruit heard loudest over O. S.; marked dilatation of angular and naso-frontal veins and also the veins of the upper lid and tiny vessels of the conjunctivum. A distinct thrill could be felt near the internal canthus. Almost a complete 6th nerve palsy with internal strabismus was present. Very slight pressure in the supraorbital region gave paræsthesias over ophthalmic division of 5th nerve, yet in this region no actual sensory changes were demonstrable, and the corneal reflex was present. Fundi showed dilated

and tortuous retinal veins but no atrophy nor œdema. Compression of the left common carotid caused the bruit to cease, but after ten minutes of compression, numbness of right arm and leg appeared. Compression of opposite carotid, left facial or temporal arteries had no effect, yet compression of the dilated veins at the inner canthus of O. S. caused the bruit to cease almost entirely. Visual fields showed no defect and X-rays of skull were negative. Blood Wassermann and urine were negative. Blood pressure was 116/76. *Treatment:* Because of the numbness of right extremities resulting from shutting off of the left carotid, preliminary graded digital compression was employed. At first ten-minute periods of compression three times a day were used and during six weeks the periods gradually increased to one hour, three or four times a day. Numbness of opposite extremity no longer resulted. The exoph-



FIG. 10.—Case II six months following ligation of dilated veins of the supraorbital region.

thalmos and bruit, however, became worse. On May 26, 1923, under local anæsthesia, the left internal carotid was exposed and compressed with a Crile clamp for sixty minutes. During this period no numbness, anæsthesia nor paresis appeared on the opposite side, and the bruit was entirely shut off. A permanent double ligature was then made. This continued to shut off the bruit subjectively and objectively and during the next two weeks exophthalmos decreased to about one-half, the pulsation was hardly visible, and the 6th nerve palsy largely disappeared (see Fig. 9). The bruit was not audible to the patient, but after two weeks it could be very readily heard by the stethoscope over the mass of dilated and pulsating veins above the inner canthus. This mass increased in size and a more distinct thrill than ever could be felt over it. On July 16, 1923, under local anæsthesia the left supraorbital and supranasal region was explored. The angular and naso-frontal veins were found to be dilated to the size of a little finger and these were doubly ligated and cut as they branched from the superior ophthalmic vein. For the following few days there was congestion about the eye and

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exophthalmos was more marked than before. Then the exophthalmos subsided and it was found that the pulsating swelling was entirely gone from the internal angle of the orbital fossa. The objective bruit, too, had disappeared, there were no signs of ocular palsies and pupil reacted normally. Some exophthalmos remained. (See Fig. 10). On January 21, 1924, the patient appeared as shown in Fig. 11. His exophthalmos had not altered during the last few months and he hears a bruit only occasionally at night while in bed. There has been, however, some increase in the size of the superficial veins of the left temporal region and of the upper lid of O. S.

CASE III.—Accident. Resulting Pulsating Exophthalmos. Rest, Morphine, Codein and Digital Compression, Cure. San Francisco Hospital No. 50391, a Ger-

man male, aet. sixty-seven and a painter by occupation had a negative family history and past history. Present illness: On January 9, 1921, the patient was struck by a street car, was unconscious for one hour and had no subsequent memory of events occurring until eight hours after the accident. Then he noticed a severe headache. He was taken to the San Francisco Hospital. Examination showed a well developed and nourished middle-aged man in a stuporous condition. There were marked ecchymoses about each orbit and X-ray of the skull showed a left frontal fracture. No cranial nerve palsies were present. Thirteen days after the accident a paresis of the internal rectus muscle O. S. appeared and four days later there was an almost complete ophthalmoplegia externa O. S. and immobile pupil. Two weeks later, exophthalmos O. S. appeared. (See Fig. 12.) About this time subjectively as well as objectively, a blowing bruit could be heard. It was almost continuous but accentuated during systole. Exophthalmos increased and there was marked chemosis. Compression of the left common carotid shut off this bruit and sometimes it would disappear of its own accord for a time. Visual fields revealed no defect but acuity was down to 20/200 in O. S. while 20/20 in O. D. Examination of fundi showed engorgement of veins and a slightly hazy disc. Urine negative; blood-pressure not elevated. *Treatment:* Simple means such as rest, morphine, codein and digital compression of the common carotid were used. Ligation of the carotid was considered but the patient seemed to be improving so rapidly that it was not done. Two weeks after the appearance of the pulsating exophthalmos it had started to subside. In five weeks more the bruit and the ocular palsy had entirely disappeared and the exophthalmos was almost entirely gone. In another month's time there was no exophthalmos and visual acuity of O. S. was 20/70. At present no exophthalmos is present (see Fig. 12), and there are no ocular palsies. Visual acuity is O. S. now only 5/200 for a cataract has developed. The disc is somewhat pale and the arteries are much smaller than on the opposite side. Visual fields are normal. From external examination of the eyes the only abnormalities to be noted are



FIG. 11.—Case III one month after accident.

slight puffiness under the eye and scleral and episcleral vessels which are larger than those of the opposite globe.

CASE IV.—This case will be merely mentioned as a preliminary report* has already been made by Doctor Yoakum and the complete report will appear elsewhere.

It was a case of traumatic pulsating exophthalmos following a gunshot wound of the head. Infection of the wound followed an exploratory operation in the region of the angle of the jaw, near the entrance of the bullet. After this the pulsating exophthalmos decreased, and now, three and one-half years later, the patient is perfectly well except for a slight abducens weakness.

Diagnosis.—The clinical phenomena of pulsating exophthalmos is easily recognized yet the decision whether the underlying pathology is an arterio-venous communication, a tumor of the orbit, or an aneurism of the internal carotid or ophthalmic artery, is often difficult.

The age of the patient is of some importance in the decision, for aneurismal types are more apt to occur in middle-aged or elderly people. An aneurismal type may, however, become an arterio-venous communicating type by the rupture of a single aneurism of the internal carotid artery lying within the cavernous sinus. The traumatic cases are nearly always actual arterio-venous communication. The presence of a pulsating




FIG. 12.—Case III two and one-half years after accident.

swelling above the inner canthus also usually means an arterio-venous type, and bruit is usually louder than with simple aneurism or with tumor. Exophthalmos is greater with tumor and the communicating type than with the aneurismal type.

With orbital tumor de Schweinitz states that the pulsating exophthalmos develops very slowly. The orbital growth, too, may often be palpable and efforts to reduce the exophthalmos are encountered with more resistance than in the other types. The bruit if present at all is very feeble.

Other conditions such as a destructive process of the roof of the orbital

* See proceeding of the Boston Society of Psychiatry and Neurology meeting at Peter Bent Brigham Hospital, January 20, 1921. Arch. Neur. and Psych., June, 1921, vol. v, p. 754.

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fossa or as an orbital encephalocele may cause pulsating exophthalmos, but here no bruit is present.

Treatment.—The treatment of this condition consists of the various therapeutic procedures which tend to prevent the direct short circuiting of arterial blood into the venous system. The three very different principles that have been applied for this purpose are the following:

(1) The production of stasis or obstruction of the blood in the arteries afferent to the arterio-venous fistula, such as compression or ligation of the carotid artery.

(2) The production of stasis or obstruction to the arterial blood in the veins afferent from the arterio-venous communication, by means such as ligation or compression of superior ophthalmic vein.

(3) Methods aimed at the promotion of clot formation in both arteries and veins such as subcutaneous gelatin injections or simple rest.

The following results have been obtained by the various different methods. (See Table V.)

Digital Compression.—Certainly has its place as a curative therapy, as well as a preparatory procedure for carotid ligation. Since de Schweinitz and Holloway's monograph in 1907 there have been 27 cases treated in this manner with 11 patients, or 37.04 per cent. cured or improved. For the complete series of 106 cases treated by digital compression the results are less striking as there were just 26.41 per cent. cured or improved. However, by comparing the results of digital compression with those of the more radical procedures (see Table V) the reader will probably agree with the author's conclusion that this form of treatment should be thoroughly tried out as the initial therapy. It has been more effective in the treatment of spontaneous cases than those of the traumatic type.

Ligation of the common carotid was the treatment employed by Travers upon his case, the first one in the literature and this was in 1805, before the days of anæsthesia. In the literature since the publication of de Schweinitz and Holloway's monograph in 1907 there have been 84 patients

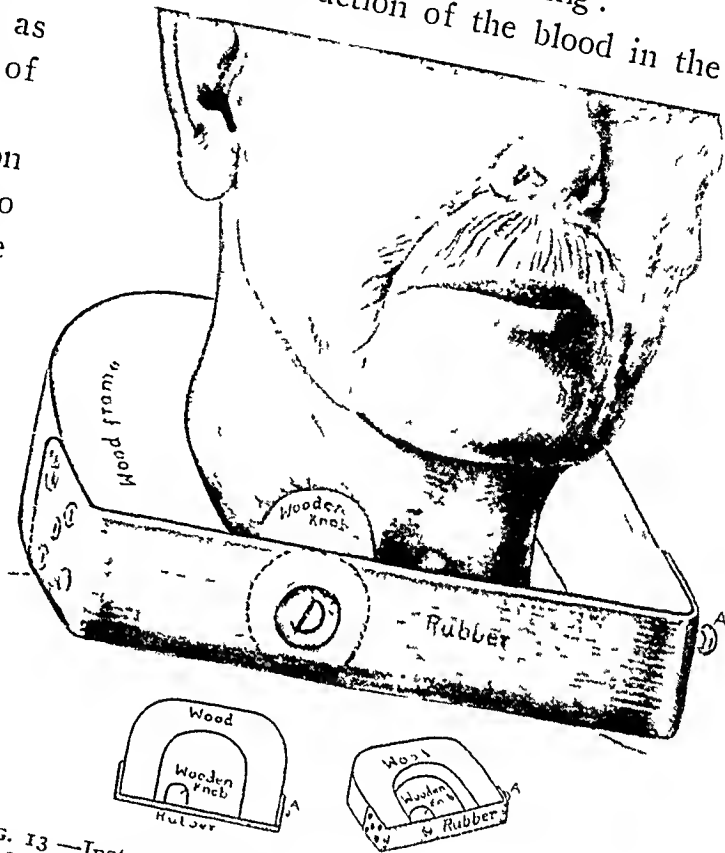


FIG. 13.—Instrument employed to compress the common carotid artery against the transverse processes of the cervical vertebræ. The wooden frame is placed in position about the neck and the rubber cross-piece is then stretched to fasten over the screw-A.

TABLE V.
Results of Treatment of Pulsating Exophthalmos.

Treatment	1923—1927			1907—1899			1923—1899	
	Series (1) Author's series	Series (2) Bedell, Rhodes, Zentmeyer, Von Nagy	Series (1) & (2) Result percentages	Series (3) De Schweinitz and Halloway	Series (4) Sattler, Reuchlin, Keller	Series (3) & (4) Result percentages	Totals	Result percentages
Digital compression.....	Total.....23 Cured..... 3 Improved.... 7 Negative.....13 Fatality..... 0 Not stated... 0	Total.... 4 0 0 4 0 0	11.11 25.93 62.96 0.0 0.0	Total.....11 Cured..... } Improved.... } Negative..... } Fatality..... } Not stated... }	Total... 68 15 53 0 0	24.05 75.95 0.0 0.0	Total...106 28 78 0 0	26.41 73.59 0.0 0.0
Ligation of common carotid	Total.....50 Cured.....16 Improved.... 15 Negative.....11 Fatality..... 5 Not stated... 3	Total....34 14 12 7 1 0	35.72 32.14 21.43 7.14 3.57	Total.....34 Cured..... } Improved.... } Negative..... } Fatality..... } Not stated... }	Total...116 80 25 11 0	64.60 25.30 10.00 0.0	Total...234 154 56 21 3	65.81 23.93 8.98 1.28
Ligation of internal carotid	Total.....25 Cured..... 6 Improved.... 15 Negative..... 1 Fatality..... 3	Total.... 7 1 6 0 0	21.87 65.64 3.12 9.37	Total..... 6 Cured..... } Improved.... } Negative..... } Fatality..... }		16.66 66.66 16.66 0.0	Total... 38 8 25 2 3	21.05 65.79 5.26 7.90
Bilateral ligation of carotids	Total..... 9 Cured..... 0 Improved.... 6 Negative..... 2 Fatality..... 1 Not stated... 0	Total.... 2 2 1 0 0 1	0.0 63.64 18.18 9.09 9.09	Total..... 1 Cured..... } Improved.... } Negative..... } Fatality..... } Not stated... }	Total... 9 6 2 1 0	60.00 20.00 20.00 0.0	Total... 21 13 4 3 1	61.91 19.05 14.28 4.76

19

Ligation of orbital veins alone.....		Total..... 8	Total..... 6	Total..... 3	Total..... 2	Total..... 19
Cured.....	2	3	35.72	3	0	8
Improved.....	2	1	35.72	1	0	5
Negative.....	3	0	21.43	2	0	5
Fatality.....	1	0	7.14	0	0	1
Total.....	10	5	20.00	0	0	42.12
Cured.....	3	4	33.33	3	0	26.31
Improved.....	1	1	20.00	1	0	26.31
Negative.....	2	0	26.67	0	0	5.26
Fatality.....	4	0		0	0	
Total.....	18	4		5	0	24
Cured.....	2	1	13.64	6	0	9
Improved.....	5	2	31.82	1	0	8
Negative.....	9	0	45.45	3	0	3
Fatality.....	1	0	4.54	2	0	4
Not stated.....	1	0	4.54	0	0	
Total.....	6	7		0	0	28
Cured.....	1	3	30.78	3	0	4
Improved.....	3	2	38.46	1	0	10
Negative.....	2	0	30.76	0	0	12
Fatality.....	0	0	0.0	0	0	1
Not stated.....	0	0	0.0	0	0	1
Total.....	16	5	33.33	0	0	14.29
Cured.....	5	5	0.0	0	0	35.72
Improved.....	6	0	66.66	0	0	42.85
Negative.....	0	0	0.0	0	0	3.57
Fatality.....	0	0	0.0	0	0	3.57
Not stated.....	0	0		0	0	
Total.....	16	5		0	0	31.25
Cured.....	5	5	0.0	0	0	31.25
Improved.....	6	0	66.66	0	0	37.50
Negative.....	0	0	0.0	0	0	0.0
Fatality.....	0	0	0.0	0	0	0.0
Not stated.....	0	0		0	0	
Total.....	16	5		0	0	0.0

treated in this manner. Of these, there were 67.86 per cent. cured or improved, with a mortality of 7.14 per cent. (See Table V). The earlier series from 1809 to 1907 shows a slightly higher mortality of 10 per cent., possibly due to the septic operative wounds which occurred frequently before Lord Lister's discovery in England and Pasteur's introduction of the aseptic operating room at "Hôpital Cochin", Paris.

Ligation of the Internal Carotid.—for pulsating exophthalmos was first

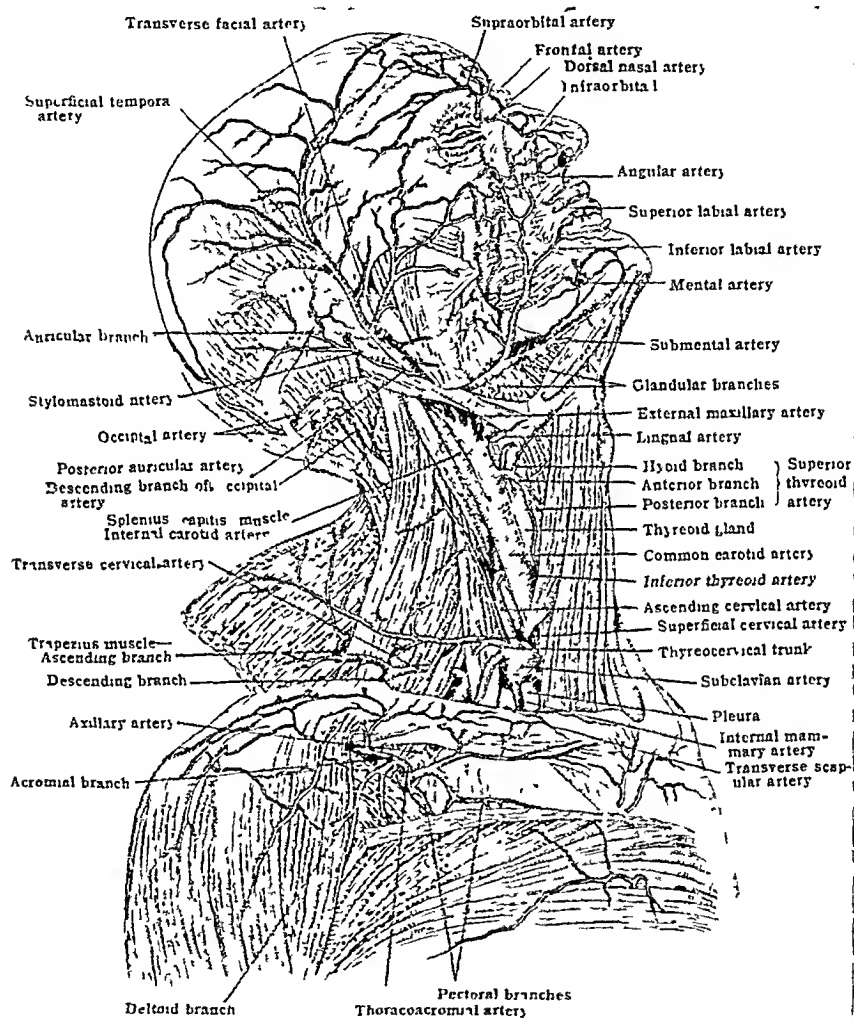


FIG. 14 —Arteries of the head and neck. (After Toldt, "Atlas of Human Anatomy," Rebman, London and New York.)

performed by Murray (New York) in 1904. Up to 1907, (de Schweinitz) there had been six cases reported with one cured, four improved, one negative, and no fatalities. The case which was cured died one month later from rupture of an aneurism of carotid near aorta. Since 1907, there have been 32 cases in which the internal carotid has been ligated with 28, or 87.51 per cent. cured or improved, and 3 per cent. or 9.37 per cent. mortality. Combining the two series there have been 38 cases in all with 86.84 per cent. cured or improved, and a 7.9 per cent. mortality. If a comparison

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is to be made between these results and those of ligation of the common carotid, the common carotid series must be taken after 1904, because fatalities from infection were greater in the foregoing period.

Bilateral Ligation of the Common Carotid.—(with interval between ligations) had been performed ten times before 1907. Since then there have been 11 more cases so treated, making a total of 21, with 61.91 per cent. cured or improved, and with a 14.28 per cent. fatality. (See Table V.)

Orbital Vein Ligation.—Ligation of the dilated orbital veins at the inner angle of the orbit for pulsating exophthalmos was performed successfully by Lansdown in 1874. From that time up to the present this operation has been performed in 43 cases with 69.76 per cent. cured or improved, and 11.63 per cent. fatality. In most of the cases in which an orbital operation was performed, the patient had previously had a carotid ligation. This is unfortunate, for the merit of the orbital operation can be justly determined only from those cases in which it was the primary operation. There have been 19 of such cases with 68.42 per cent. cured or improved, and 5.26 per cent. fatality.

Rest and Medication.—Of the entire number of cases reported in the literature only very few were cured by simple means such as rest and medication. In de Schweinitz and Holloway's own series, six cases were treated in this manner and of these there have been 23 more cases treated in this fashion, making a total of 28 cases of which there have been 4, or 14.29 per cent. cured; 10 or 35.72 per cent. improved, and 13, or 42.85 per cent. negative, and 1 or 3.57 per cent. fatality.

Gelatin Subcutaneous Injections for treatment of pulsating exophthalmos introduced by Paulesco³⁰ had been employed three times up to 1907, with one cure and two improvements. The total cases treated in this manner has now reached 16, of which 5 were cured, 5 improved and 6 negative. Thus 62.50 per cent. of the cases were cured or improved. A warm 2 per cent. gelatin solution has usually been used for the treatment. From 100 to 250 c.c. are injected subcutaneously every 4 to 8 days.

DISCUSSION AND CONCLUSIONS CONCERNING TREATMENT

The beneficial results from these various forms of treatment are dependent upon the decrease of blood going to or from the arterio-venous fistula, without diminishing the blood supply of that side of the brain sufficiently to cause death or hæmiplegia. In order to reduce these dangers to the very minimum, I believe that a course of carotid compression should precede every ligation operation.

In a given case of pulsating exophthalmos the treatment to be selected will largely depend upon the results of the carotid compression test. The following three examples are illustrative:

1. If prolonged periods of carotid compression stop the bruit and do not cause signs of cerebral anæmia, beneficial therapeutic results are to be

expected. This may be interpreted as meaning a sufficient anastomosing circulation from the opposite carotid or from the vertebral arteries to properly nourish the hemisphere, yet not a sufficient supply to maintain the arterio-venous communication. In young individuals this type of case should not have too lengthy a course of carotid compression therapy. Such treatment, if it does not early cure the condition, will merely tend to increase the anastomosing circulation so that a subsequent carotid ligation will not entirely shut off the bruit. In this type of case complete rest, subcutaneous gelatin injections and not less than one week's course of carotid compression in young individuals and three week's course in middle-aged or elderly individuals are to be recommended. In case of failure of these procedures ligation of the carotid, by the method described by the author (see below) is indicated.

2. *If the carotid compression test shuts off the bruit yet gives headache, or motor or sensory signs on the opposite side,* a thorough course of compression is indicated. Complete rest and subcutaneous gelatin injections may be carried on at the same time. The compression treatment should be given 4 to 10 times daily and increased from day to day until it is possible to constrict the artery for an hour at a time without the development of motor and sensory signs on the opposite side of the body. Figure B shows an instrument devised for the purpose of prolonged carotid compression. A thorough compression treatment is especially important in middle-aged or elderly individuals. It will prepare sufficient anastomosing circulation to alleviate the danger of subsequent carotid ligation and will, moreover, give ample time for cure in those cases in which conservative therapy is going to be successful.

3. *If the carotid compression test neither shuts off the bruit nor causes signs of brain anæmia,* then a prolonged course of carotid compression merely for therapy will not be of much value. However, a 1 to 3 weeks course, depending upon the age of the patient, will be necessary for safety as a preliminary measure to carotid ligation. The latter procedure is indicated but the surgeon will not be very confident of success.

By examination of the comparative results of common carotid and internal carotid ligation (Table V) it will be seen that there is but little advantage of one over the other. Between 1907 and 1923 there have been more cured and improved from internal carotid than from common carotid ligation, yet with this there has been a slightly greater mortality. Only as case reports increase in number will it be possible to judge which of these two procedures is the better. Either one is comparatively safe when preceded by a course of carotid compression. Out of the 13 cases in the literature treated in this manner, there were no fatalities nor ill results. It seems to the author that Murray's logic was good in suspecting fewer recurrences after internal carotid ligation. However, without a course of carotid compression it is probable that the mortality of internal carotid ligation would be greater than from common carotid ligation.

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The mortality following carotid ligation may not only be reduced by the pre-operative procedure just mentioned, but also may be materially reduced by certain operative and post-operative precautions. The dangers to a patient from carotid ligation, I believe, are twofold. The first and immediate danger, that of unilateral brain anæmia from lack of blood supply, and the second, the danger from embolus or an extension of a thrombus,[†] which may cause an accident some days after the ligation. Both of these dangers may be minimized at the operating table by the procedure employed by the author.

Method of Carotid Ligation.—Under local anæsthesia the carotid is exposed, gently compressed and shut off with a Crile clamp. This temporary obliteration is maintained for a period of one hour. During this interval the wound is covered with gauze moistened in Ringer's solution and the patient is asked frequently whether there is headache, or feeling of numbness or weakness, etc., of the opposite extremities. Objective tests are also made. Should any signs develop, the clamp is immediately released, and the ligation abandoned until a later date after another course of digital compression. The danger of embolus and thrombosis I attempted to minimize by keeping the patient absolutely quiet for the first week after operation. He is told not to move at all, not even his arms and legs, and he is fed, turned and waited upon hand and foot by the nurses and orderlies. What is more, in the ligation itself, care is used to employ a ribbon ligature which is tied only tight enough to shut off the artery and not tight enough to injure the walls of the vessel.

Should ligation of the carotid fail and if there is a persistent enlargement and thrill of the ophthalmic veins and their branches, I believe that a ligation of these distended vessels is indicated. Even this operation although seemingly simple has a considerable mortality and with a smaller percentage of cures and improvements than carotid ligation. It should then be employed when carotid ligation has failed and under no condition should an attempt be made to do an orbital vein ligation and a carotid artery ligation at the same sitting. The results have been exceedingly unfortunate in the cases so treated. After a distal ligation of the orbital veins their lumina no doubt become filled proximally with organized clot. The extent of this process to the opening of the arterio-venous fistula is probably responsible for the cures that sometimes follow.

In case neither ligation of the internal carotid nor of the superior ophthalmic vein effects a cure, ligation of the opposite carotid may be performed. However, because of the high mortality accompanying this procedure the surgeon must assure himself by prolonged periods of digital compression that no accidents will follow. The method suggested by the author, of operating under local anæsthesia and temporarily occluding the carotid before its permanent ligation should reduce the danger of this operation.

[†] De Fournestaux: Les accidents cérébraux et Oculaires consécutif à la ligature de la Carotide Primitive. These, 1906-1907, No. 292.

ACKNOWLEDGEMENTS.

I am very much indebted to Dr. H. C. Naffziger, the Chief of the Neurosurgical Division of the University of California, for valuable suggestions in the preparation of this article.

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CHRONIC PRODUCTIVE THYROIDITIS

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CHRONIC productive thyroiditis, Riedel's iron-hard struma, benign granuloma of the thyroid (Ewing), or ligneous thyroiditis (Delore) is rather a rare lesion of the thyroid gland. The reports of the following three cases may, therefore, be of interest.

CASE I.—White female, thirty-five years of age, the mother of one child, thirteen years old both of whom were syphilitic. The patient had six miscarriages, all before the third month, without apparent cause. She had not been pregnant since her second marriage, which took place six years before she came under observation. Four years prior to the time the patient came under observation, she took thyroid extract for a period of one year, for obesity; it did not have any effect on her weight, but produced marked palpitation of the heart. In October, 1904, the symptoms still continued attacks which were said to be asthmatic. In January, 1905, the patient began to suffer from and, in addition, there was dyspnoea on exertion, wheezing at times without exertion, and almost constant hoarseness, except for periods of a few days.

In January, 1905, when the patient's symptoms became aggravated, she consulted Doctor Huddleston, who noticed slight enlargement of the thyroid. He placed her on mixed treatment, consisting of potassium iodide and protiodide of mercury. There was no change in the swelling or other symptoms and, during March, 1905, she frequently had fever, ranging from 100 to 101° F., and occasional chills.

In April, 1905, the patient came under the observation of Drs. W. T. Bull and Eugene H. Pool. At that time she showed marked dyspnoeal distress, with shallow rapid, wheezing respiration. The pulse was rapid and irregular; heart and lungs negative; no evidence of syphilitic lesions on skin or elsewhere. Over the lower part of the neck there was a slight fullness, suggesting a diffuse goitre; this area was very hard, especially on the left side and in the region of the isthmus of the thyroid gland. Examination by Doctor Lefferts showed the vocal cords to be normal, but the tracheal walls on both sides were compressed, narrowing the lumen of the larynx to a slit-like orifice.

On April 22, 1905, the patient was operated upon by Dr. W. T. Bull, assisted by Dr. Eugene H. Pool under chloroform anæsthesia. A median incision was made from the incisura of the thyroid cartilage to the sternum, and a horizontal incision, 2 inches long, on the left side, from the centre of the vertical incision. At the site of the cricoid cartilage and the trachea, for a distance of one inch, there was a smooth, bony hard tissue, cutting like cartilage, apparently $\frac{1}{4}$ inch thick, and inseparable from the trachea. Laterally it seemed to embrace the tracheal tube closely. The thyroid gland was not indented. The trachea was opened just above the plane passing through the upper limit of the sternum, and a tracheal tube was inserted. The tissues were then sutured.

Five days after the operation, the patient developed erysipelas and died after a sudden arterial hemorrhage.

Post-mortem inspection by Doctor Pool showed a thyroid of about normal size and very hard, constricting the trachea and obstructing its lumen, as described by Doctor Lefferts. There was nothing pathologic in any of the tissues adjacent to the thyroid. The thyroid was composed of connective tissue, evidently a replacement fibrosis, except

for a small area at the right upper pole, about 1 cm. in diameter, which showed some evidences of acini in various stages of obliterative compression. The histological sections showed a chronic inflammatory process with obliterative endarteritis.

Pathological Diagnosis.—Chronic productive thyroiditis—non-luetic.

CASE II.—Lieutenant-Colonel, A. P. S., white male, twenty-five years of age, Russian aviator, was admitted to Presbyterian Hospital, New York, on December 9, 1919 (No. 44229), service of Dr. G. E. Brewer, with a history of swelling in the neck in the region of the thyroid, dyspnoea, and difficulty in swallowing; onset some three

months prior to admission. Past history irrelevant; venereal history denied.

Physical examination was negative, except for dyspnoea, polynoea, and the presence of a mass, about the size of a hen's egg, intensely hard, corresponding to the position of the right lobe of the thyroid.

On December 9, 1919, the patient was operated upon under general anaesthesia. An incision 6 inches long was made along the anterior margin of the sterno-mastoid muscle on the right side, with extension downward over the right sterno-clavicular joint. The right lobe of the thyroid was involved by a new growth which extended out and into the surrounding



FIG. 1.—Case I.

tissues, causing great increase in the density of the capsule of the gland, enclosing the recurrent laryngeal nerve and extensively adherent to the trachea and oesophagus. The lower pole of the tumor was well below the clavicle. The consistency of the tumor was very hard and it was only slightly movable. There was increased vascularity of the region.

Procedure.—Incision deepened through platysma; sterno-thyroid and sterno-hyoid muscles were divided across, the former being noticeably adherent to the right lobe of the thyroid. The capsule of the gland was exposed with great difficulty. Numerous branches from both the superior and inferior thyroid arteries were ligated. In order to free the inferior pole and to make sure of controlling hemorrhage from the inferior thyroid vessels, the incision was extended down over the sternum and a subperiosteal resection of the inner 3 cm. of the right clavicle was performed with a Gigli saw. The inferior thyroid vessel was then doubly ligated and the gland was removed by sharp dissection along the right aspect of the trachea. In this region considerable new growth was left where it had become incorporated in the wall of the trachea. This was done because it was manifestly impossible to remove the 2 or 3 inches of trachea apparently involved. The superior thyroid vessels were ligated and removal of the right lobe completed. A large rubber tube was split and used to cover the carotid artery and jugular vein. One hundred and twenty mgs. of radium were inserted in a small rubber tube and placed alongside the above-mentioned portion of trachea, the lower end of the

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tube being in the lowermost depth of the wound. Incision closed by plain interrupted sutures for muscles, silkworm interrupted sutures for skin. Time of operation 1 hour, 33 minutes. Time of anaesthesia 1 hour, 40 minutes. Radium removed on December 10, 1919, 3:30 p. m., and wound dressed. December 16, 1919, marked difficulty in swallowing. December 21, 1919, radium applied for 4 hours. Subsequent progress of patient uneventful. Discharged as cured on January 3, 1920. No recurrence of symptoms; patient alive and well 4 years after operation.

Pathological Report.—The gross specimen consisted of thyroid tissue, seemingly one lobe, and 3 cm. of the extremity of the clavicle. The dimensions of the thyroid were 3 cm. in length, $4\frac{1}{2}$ cm. in width and $4\frac{1}{2}$ cm. antero-posteriorly. The tissue was hard and firm, definitely encapsulated, with no regularity on the surface. The mid-portion of the thyroid was almost stony hard. On section, at about its centre, corresponding to the area of extreme hardness, there was about 0.9 cm. of soft succulent material. Around this the tissue was hard and firm, and in the upper portion of the gland the same succulent material was found. The tissue comprising the thyroid bore no resemblance to the normal thyroid tissue. The bone presented no unusual abnormalities.



FIG. 2.—Case II.

Microscopic Examination.—The bulk of the tumor mass is made up of exceedingly diffuse connective tissue, infiltrating between the acini of the thyroid. This connective tissue is degenerated, forming dense bands. There are round cells sparsely scattered throughout this dense mass, and at points between the thyroid acini. The degenerative phenomenon suggests the precursor of calcification and ossification. The picture is that of an exceedingly chronic inflammation. It suggests the site of an injury with hemorrhage, repair and inflammation. *Diagnosis:* Chronic inflammation (W. C. Clarke).

Note.—“A review of these slides (No. 23773) after reference to Ewing's book ‘Neoplastic Diseases’ leads me to suppose that this case corresponds to Riedel's iron-hard struma.” (A. P. Stout.)

CASE III.—This case occurred in the author, a white male, thirty-one years of age. *Previous History.*—Measles, catarrhal croup, chicken-pox in infancy. Several attacks of tonsillitis; occasional attacks of gastric disturbance during childhood. In-

fluenza (severe) while in France in 1918, again in 1920. The last attack of influenza was followed within two weeks by an attack of nasal diphtheria. Prior to 1911, the patient was rather thin and under-weight. During the summer of 1911, however, there was a sudden gain in weight (about 20 pounds within five weeks), after which hair on scalp began gradually to fall out. In December, 1922, noticed that neck was becoming larger.

In March, 1923, the patient experienced difficulty in swallowing food, which gave the sensation of being "caught" in the œsophagus and, in the case of liquids, there was regurgitation at times. Some



FIG. 3.—Case III

dyspnœa on exertion was also noticed. The symptoms continued and seemed to become aggravated, particularly the difficulty in deglutition. Carcinoma of the œsophagus was thought of, but the peculiar history of difficulty in swallowing did not coincide, *i.e.*, solid food (meat) often gave no symptoms, whereas liquids, particularly cold drinks, seemed to produce a spasm in the pharynx and regurgitation, or repeated efforts at swallowing. Pains, aching in character and at times knife-like, girdled the upper portion of the thorax, coming on without apparent cause, not related to swallowing, and usually of short duration. X-rays of the œsophagus and gastro-intestinal tract revealed no abnormalities. X-rays of the chest and thoracic spine showed no pathologic process.

Physical examination by Dr. N. Stadtmuller showed a well-developed, somewhat

obese male. The heart was slightly hypertrophied to the left by percussion (negative by X-ray); average pulse rate 116; blood-pressure 110-85; average temperature 99.6; urine negative; weight 217 pounds dressed; height 5 feet, 10½ inches; Wassermann reaction negative (Wassermann in 1913 negative); remainder of physical examination negative.

On July 3, 1923, the patient quite accidentally, on turning his head to the left, noticed a hard swelling protrude just above the sternum and in the region corresponding to the right lobe of the thyroid. This was diagnosed as a calcified thyroid adenoma. X-ray showed no calcification, but marked displacement of the trachea to the left. On July 24, 1923 the tumor in the neck appeared slightly larger. Dr. F. Torek was consulted and operation advised.

Operation.— July 26, 1924, under local anæsthesia. Platysma divided; right thyroid exposed and found adherent to sterno-thyroid and sterno-mastoid muscles. Former divided, disclosing a hard tumor mass, about three-fourths the size of a hen's egg, firmly

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adherent to the trachea. Right lobe and part of isthmus removed, after considerable difficulty in separating it from the trachea. Recurrent laryngeal nerve intact. Muscles sutured with interrupted chromic catgut; skin with interrupted silkworm gut.

Post-operative Course.—Hoarseness of the voice was noticed on the second or third day following the operation. Recovery was uneventful, except that the wound drained for about one month, discharging small amounts of brownish, clear fluid. Unilateral paralysis persisted and still exists (8 months post-operative). This condition is thought to be a unilateral paralysis due to a "pulling" injury without severing the nerve, and resulting in a degenerative neuritis from which complete recovery is expected.

Pathological Report.—The specimen consisted of an ovoidal mass removed from the thyroid, measuring about 4 cm. in length and 2 cm. in thickness, with some muscle tissue attached. The mass had been cut down the centre and was stony hard in consistency, presenting an irregularly granular, cream-colored surface.

Microscopic examination showed the presence of a chronic productive inflammatory process in which there was considerable hyalinization of connective tissue. In the microscopic sections the inflammatory tissue was seen invading adjacent muscle fibres. There was nothing in the growth to suggest a neoplasm.

Pathological Diagnosis.—Chronic productive inflammation of thyroid gland. (Douglas Symmers).

Citation of the above three cases is made in some detail because of the lack of literature on this peculiar condition. Chronic productive inflammation of the thyroid, such as described by Riedel, is referred to only in one English text-book, so far as I can ascertain, and, except for the publication of one recent case report, no other mention is made of the lesion. In the foreign literature likewise there is only Riedel's original communication, one by Bruno Selitscheck, and one or two references by French writers. Hashimoto, in 1912, reported several cases in which there was marked round-cell infiltration.

Although the lesion is relatively rare, it nevertheless forms a definite pathological entity. Ewing has seen four of these cases, all without re-



FIG. 4.—High power section of Case III.

currence after removal. Crile, in his experiences in thyroid disease at Lakeside Hospital, has encountered thirteen well-defined examples. At the Mayo clinic forty-eight cases were encountered amongst ten thousand five hundred thyroidectomies.

The etiology is obscure. Pool suggested the possibility of lues as a cause in view of his experience with one case. Riedel's original contention, *i.e.*, that it is the result of an infection, is somewhat indefinite. Some text-books suggest that acute suppurative and non-suppurative thyroiditis results from severe infections, such as diphtheria, scarlatina, typhoid, etc., whereas chronic thyroiditis results from comparatively mild infections, such as tonsillitis, la grippe, etc. These etiological factors seem equally vague and indefinite and are probably based somewhat on Riedel's work. Ewing does not believe that syphilis is a factor nor that it is related to a true tumor process.

Replacement fibrosis of a degenerating adenoma is possible, though degeneration in these tumors is generally in the form of a cystic degeneration. The possibility of hemorrhage into the thyroid as a result of disease or trauma to a vessel, with subsequent replacement fibrosis in a manner analogous to the development of a uterine fibroid, is likewise, though to a less extent, open to the same criticism.

CONCLUSIONS

1. Riedel's iron-hard struma is analogous to chronic productive thyroiditis.

2. It is a comparatively rare lesion.

3. Its etiology is obscure, though the possibility of its pathogenesis in the form of an end-process, in association with infections, adenomata and organization following hemorrhage must be considered.

4. It is generally considered malignant clinically, but its benign nature is apparent upon histologic examination. No recurrence has been reported in the literature.

5. Operative removal is the usual form of treatment. However, it may be well worth while to attempt its removal by radium or Röntgen-ray treatment, providing the benignity of the lesion is first established.

I wish to thank Doctors Pool, Brewer, Torek and Stadtmuller for permission to publish these cases; Drs. W. C. Clarke, A. P. Stout, Douglas Symmers, James Ewing, George W. Crile and John de J. Pemberton for their personal interest and aid, and especially Dr. J. E. McWhorter, who first called my attention to Riedel's struma and rendered much aid in preparing this paper.

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THE PRESENT STATUS OF THE SURGICAL TREATMENT OF CHRONIC DUODENAL AND GASTRIC ULCER*

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THE surgical treatment of chronic duodenal and gastric ulcer is still a matter of controversy both as to operative indications and the best type of procedure. As the two groups present radical differences in pathology prognosis and surgical management it is well to consider them separately. Acute perforations will not be considered in this paper as the problems involved are quite distinct and demand special consideration.

Chronic Duodenal Ulcer.—As to indications for surgical treatment in this group most surgeons differ less from the medical viewpoint than is popularly supposed. They are quite content to let the internist treat these cases, as long as physician and patient are satisfied that treatment gives relief and a cure is being effected.

We agree with the internist that early uncomplicated cases should first receive medical treatment and that a considerable number of patients are cured or at least kept in reasonable comfort thereby for long periods of time. It is a well recognized fact that many patients prefer to bear recurrent periods of discomfort, rather than submit to the hazards of an operation, and are willing to accept a certain percentage of risk as to the possible occurrence of hemorrhage, perforation or obstruction.

The surgeon has no quarrel with such patients provided they have a clear understanding of the situation. Ample opportunity for surgery exists in patients who fail to respond properly to medical treatment; in those unwilling to endure repeated relapses, and in cases in which complications threaten or occur.

We prefer that patients should have had a thorough and intelligent trial of medical treatment before surgery is considered and have repeatedly expressed this view to patients with early symptoms of short duration, a fair number of whom never come to operation. I would emphasize especially those in whom a hasty or ill-founded diagnosis has been made unsupported by adequate clinical symptoms. While I wish in no way to disparage positive X-ray evidence of ulcer so often valuable and unmistakable, I do feel that the greatest care should be taken in the interpretation of short series of doubtful plates. Cole's insistence on the need of a sufficient number of plates for safe interpretation has been a great advance in this particular diagnostic field. The Röntgen diagnosis of adhesions about the duodenum and gall-bladder giving the impression that ulcer or some surgical lesion may be present, with-

* Read before the New York Surgical Society, February 27, 1924.

out venturing a positive opinion, must also be taken with caution as we have seen many negative explorations in such cases.

To return to the management of uncomplicated chronic duodenal ulcer, which has resisted medical treatment; in which the diagnosis after careful study seems reasonably certain, and in which the need for surgery of some sort is conceded. We have been considerably disturbed by the tenor of several papers and discussions, and the attitude of a number of prominent surgeons

as expressed at recent important meetings, notably in the New York Surgical Society during the past year; at the Clinical Congress of Surgeons held in Chicago in October, 1923, and at the last meeting of the Southern Surgical Association.

The attitude which disturbed us was the tendency to advocate radical measures of resection, often of large portions of the healthy stomach for the surgical cure of this disease. We cannot subscribe to the recent wave of enthusiasm for these radical methods, which seems to be gaining so many advocates. A distinguished foreign surgeon has recently been demonstrating partial gastrectomy under local

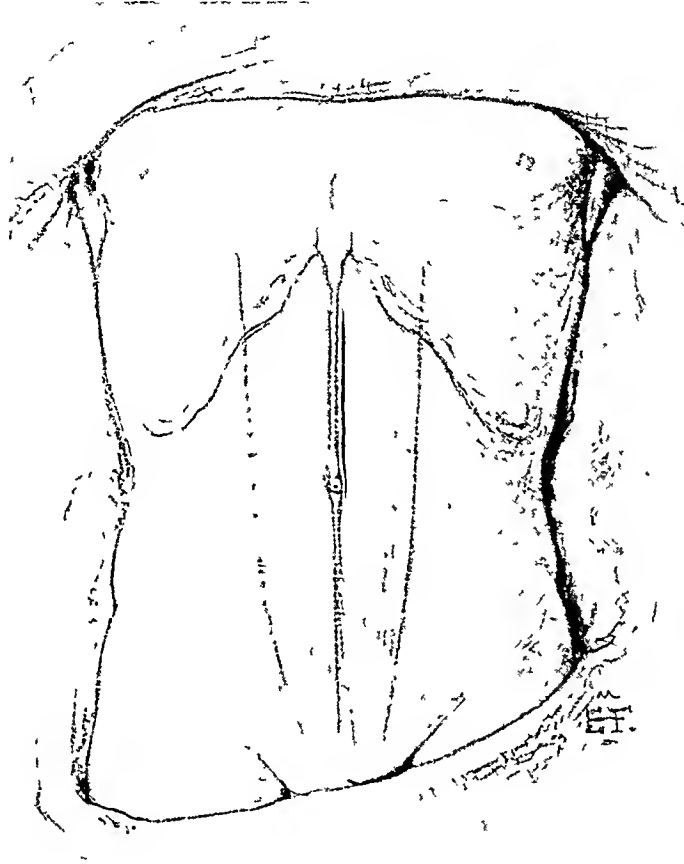


FIG. 1 —The incision is made a little to the left of the linea alba, above the umbilicus. The operator stands on the patient's left. This incision falls directly over the point of anastomosis, in line with the cardiac orifice and the duodeno-jejunal junction.

anæsthesia for this type of case, removing a considerable portion of the healthy stomach for the purpose of getting rid of small uncomplicated duodenal ulcers. One of the arguments advanced in support of the procedure is that it lessens or removes the danger of the subsequent development of gastro-jejunal ulcer, which occurs in about 2 per cent. of cases following gastro-enterostomy. Von Haberer, of Innsbruck, advocates extensive resection followed by gastro-duodenal anastomosis, a modification of the Billroth I method of gastric resection, and has numerous admirers and imitators in this country. One of the soundest and safest of our American surgeons has recently brought forward a method of excision in which the

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cut end of the stomach is anastomosed to the side of the mobilized duodenum, the cut end of which has been closed by a purse-string suture, *i.e.*, a new type of pylorectomy. He has never liked gastro-enterostomy nor has he practised it to any extent in his clinic. When he refers to it in discussions it is generally to condemn it and to cite some case in which it has failed to relieve the condition for which it was done.

Our own experience and belief is that simple gastro-enterostomy properly performed, is curative and adequate in the great majority of chronic duodenal ulcers: that from 80 per cent. to 90 per cent. of the patients so treated are completely relieved of their symptoms and remain well as they are followed year after year: that the operation is as successful in the average case without obstruction as in those with it: that malignancy develops so rarely as to be a negligible factor in prognosis. We do not believe in nor have we practiced any method of pyloric exclusion; our experience with this procedure therefore is nil. We have yet to see reported any series of cases which would support the claims made by the advocates of this procedure. The viewpoint of surgeons who believe in this method who we have heard discuss the question has been quite theoretical and unsupported by any considerable amount of experience.

We have certain ideas as to why gastro-enterostomy so often effects a cure in chronic duodenal ulcer, and believe that mechanical and chemical factors in its etiology have a distinct bearing on the results. The ulcers nearly all develop within $1\frac{1}{2}$ inches of the pylorus, the part of the duodenal wall subjected to the impact of spurts of acrid stomach content, pumped intermittently through the pylorus as though by the piston of a powerful syringe. This stomach content is often equivalent to a strongly irritant or even corrosive chemical compound, not entirely dependent on the amount of hydrochloric acid present for its irritant character. When we think of the combinations of food and drink with which most of us from time to time insult our gastro-intestinal tracts, it is not surprising that by the time the mess is pumped in spurts through

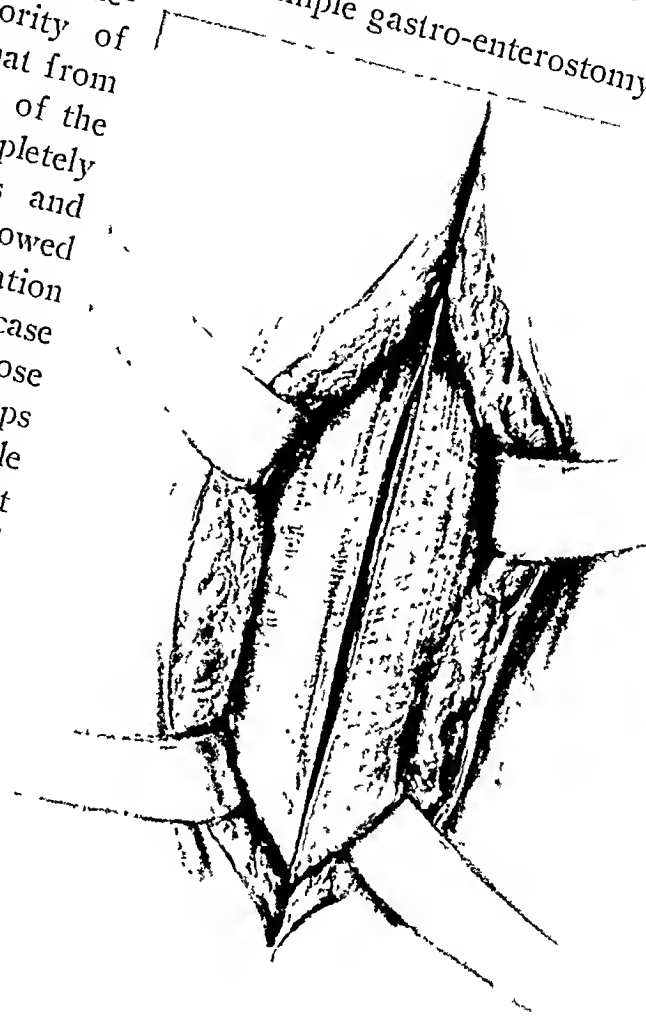


FIG. 2.—The incision leaves just enough of the edge of the rectus sheath to assure secure closure of the abdominal wall.

E. M. French.

the pylorus, it is acrid enough to cause definite injury to the delicate duodenal mucous membrane. When the ulcer is once formed, as Codman well says, it may be likened to a fissure in ano; an ulcer within the grip or influence of a constantly moving sphincter, irritated by the impact of acrid stomach content, with little chance to heal and every chance to become deeper and develop a zone of chronically irritated and inflamed tissue around it.

Gastro-enterostomy modifies both chemical and mechanical influences:

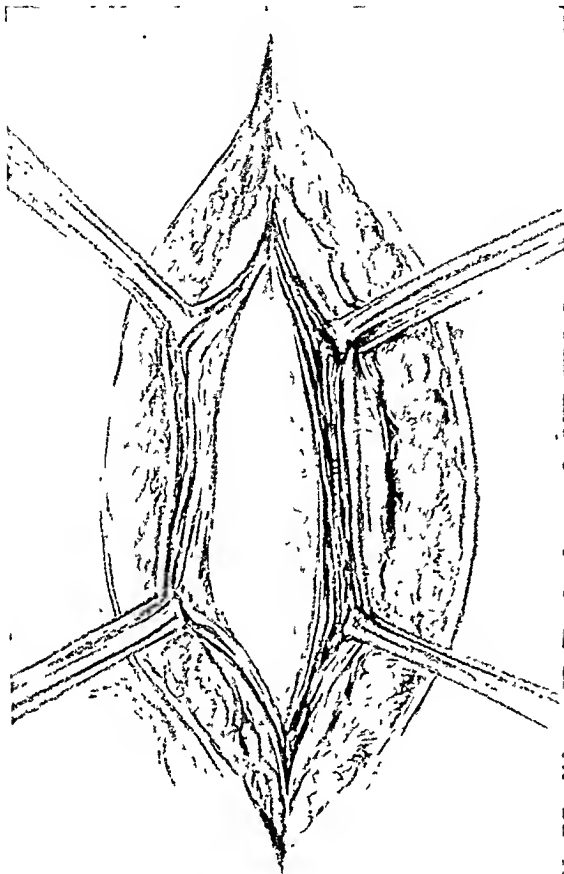


FIG. 3.—The incision leaves just enough of the edge of the rectus sheath internally to assure secure closure of the abdominal wall.

1. It lessens the irritant character of the stomach content, partly by shortening the length of time in which it is churned about in the stomach; partly by actual diminution of the acidity.

2. It greatly lessens the amount of stomach content still passing through the pylorus, even when there is no obstruction, and also the force of impact on the ulcer area of that which does pass.

Whatever the real explanation may be, we have abundant clinical evidence that duodenal ulcers heal after gastro-enterostomy; that they remain healed and that patients are permanently cured by their symptoms in a large percentage of cases so treated.

We do not believe that gastro-enterostomy should go into the discard in the treatment of duodenal ulcer nor do we believe that extensive resections of normal stomach are justifiable for this lesion.

We are unconvinced that resection to prevent the formation of gastro-jejunal ulcer is a proper procedure in the ninety-eight cases who do not need it to possibly avoid its occurrence in the other two. The other two might well be dead before the hundredth case is reached if this were made a routine operation. Moreover we believe that with a well-planned and uniformly executed technic for gastro-enterostomy that even the 2 per cent. of gastro-jejunal ulcers may perhaps be reduced to a lower figure.

The choice of procedure is a problem of prime importance and depends to some extent upon the pathologic type of the ulcer. For a better understanding of this it is well to group the cases into general types: Leaving out acute per-

forations which constitute a special problem, four such groups will be sufficient for our purpose.

1. Small, single, anterior wall ulcers, without narrowing of the gut, susceptible of local excision, without encroaching on the duodenal lumen or pylorus to any extent. As recently pointed out by Judd and Rankin, local excision without gastro-enterostomy is quite sufficient in this type; but the percentage of ulcers suitable for this procedure is limited.

2. Chronic indurated ulcers without obstruction; single or multiple. We include in this group ulcers of the chronic perforating type; with adhesions fixing the duodenum or inflammatory mass. A majority of all duodenal ulcers fall in this class.

We have had many cases of chronic perforating ulcers without hemorrhage, but with extensive adhesions, fixation of the duodenum, sometimes a considerable inflammatory mass. In many of these cases radical resection would be difficult, hazardous or quite impossible. If resorted to at all in this type it is well to do a gastro-enterostomy first, following by resection as a two-stage procedure ten to fourteen days later. The inflammatory mass may be found greatly diminished in size, fixation



FIG. 4.—An opening is made in the transverse meso-colon (insert A) and the stomach drawn through. Shallow curved Moynihan clamps are placed on stomach and jejunum. A point on the stomach is selected near the greater curvature, directly in line with the cardiac orifice, and overlying the duodenal junction, usually about $3\frac{1}{2}$ inches to the left of the pylorus. From this point the line of the clamp runs a little obliquely to the left, toward the lesser curvature (insert B). The jejunum is grasped about 3 inches from its origin. The distal point on the jejunum must correspond to the point nearest the greater curvature on the stomach. Stomach and jejunum are joined by a continuous stitch of linen or gut for a distance of $2\frac{1}{2}$ inches. Openings $1\frac{1}{4}$ inches long are then made in each viscus.

less marked, and radical excision much easier and less dangerous. We believe, however, that gastro-enterostomy alone will cure a large percentage of these cases and that more radical methods are generally unnecessary and unwarranted.

3. Cases with duodenal stricture or so-called pyloric stenosis, a group in which gastro-enterostomy is the ideal operation, and in which there is the least controversy as to its efficiency. In no field of major surgery are the results of a relatively simple operation more brilliant and lasting.

We have repeatedly operated upon cases with the strictures so tight, and

starvation and dehydration so extreme, that the condition at the time of operation was most critical.

Preliminary hypodermoclysis; blood transfusion and operation under local anæsthesia often aid in obtaining a successful outcome.

4. Cases in which severe hemorrhage has occurred, single or repeated. Hemorrhage occurs most frequently in deep penetrating ulcers on the posterior wall or against the head of the pancreas; often also in multiple ulcers.

We have seen patients die of duodenal hemorrhage before any operation

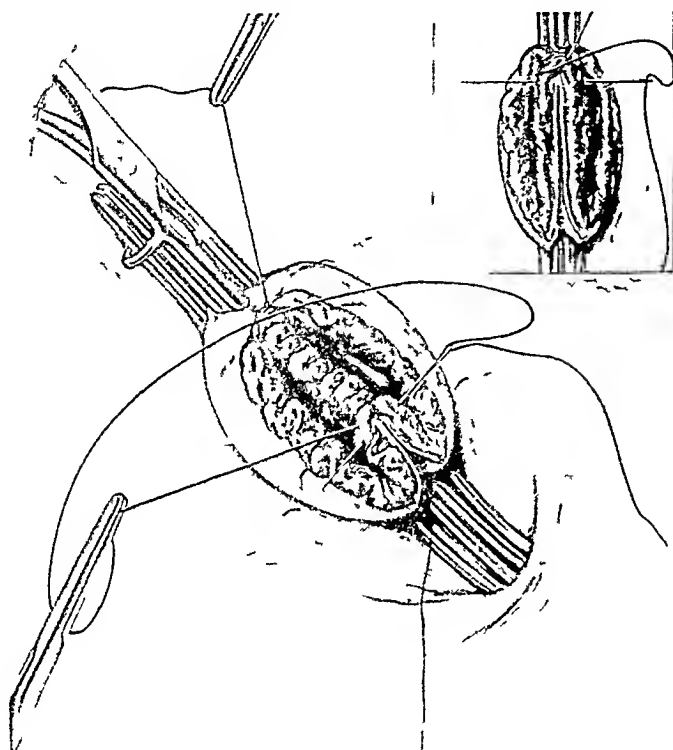


FIG 5 —The cut edges of the posterior half of the opening are sutured with a simple continuous stitch of tanned gut. Care is taken that each stitch shall include all layers of the wall of both stomach and jejunum (insert), that spacing shall be accurate, and tension just enough to secure firm contact without blanching the tissues. The mucous membrane is purposely left redundant to insure accurate apposition, and complete covering of cut edges. Absolute hæmostasis is insured if this suture is properly made.

could be performed; cases so exsanguinated that preliminary blood transfusion alone made operation possible.

Gastro-enterostomy is not a guarantee against recurrence of hemorrhage which may prove fatal. If the patient's condition permits, excision of the ulcer area is desirable in this group. If the danger of radical excision seems too great in exsanguinated or debilitated cases, gastro-enterostomy may be sufficient or it may be done as the first step of a two-stage operation. It is our belief that the average duodenal ulcer heals within two or four weeks after gastro-enterostomy, but fresh hemorrhage may

occur before time for such healing has elapsed. Repeated blood transfusions in moderate amounts (300 to 500 c.c.) is especially valuable in these cases.

We have had several hemorrhage cases in which gastro-enterostomy has effected a cure without return of the bleeding; and a few cases in which we have performed immediate pylorotomy. We were once reluctantly forced to operate on a woman seventy-four years of age for repeated duodenal hemorrhage extending over a period of fifteen months. Simple gastro-enterostomy was done, there was no recurrence of hemorrhage and she is alive and well, eating heartily, without symptoms at the age of eighty-three. We have found that hemorrhage either from stomach or bowel or both occurred in about 14 per cent. of our cases.

We believe that radical resections should be reserved for the small per-

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centage of cases in which gastro-enterostomy has failed to relieve the ulcer syndrome; for certain hemorrhage cases; cases of inflammatory mass in which malignancy may be suspected (a two-stage procedure), and possibly for the 2 per cent. in which gastro-jejunal ulcer develops. If gastro-enterostomy is to be successful and free from complications, it is essential that a well thought out, routine technic should be employed. In perhaps no operation are slight errors in detail more fraught with danger of subsequent trouble.

We are quite aware that our own method is not the only good one, but in our experience it has proved satisfactory and free from early or late complications. We believe that every surgeon should carefully work out the details of the routine which in his hands gives a uniformly smooth post-operative course. We have had only two cases of vicious circle, on our series, both occurring in cases in which the gastro-enterostomy had to be done through an incision planned for other work

owing to an error in pre-operative diagnosis. Both cases recovered after secondary entero-enterostomy and are now well and free from symptoms at seven years, ten months, and three years ten months respectively.

Operative Technic.—There are several points in technic which we believe to be of importance in the operative procedure.

Our own routine is to stand on the patient's left, and make a left paramedian incision. This falls directly over the site where the stoma is to be made, and where the duodeno-jejunal junction lies. The stoma is placed at the most dependent part of the greater curvature, in a line directly below the cardiac orifice. First the stomach, then the jejunum are grasped with shallow curved Moynihan stomach clamps. The placing of the clamp on the stomach

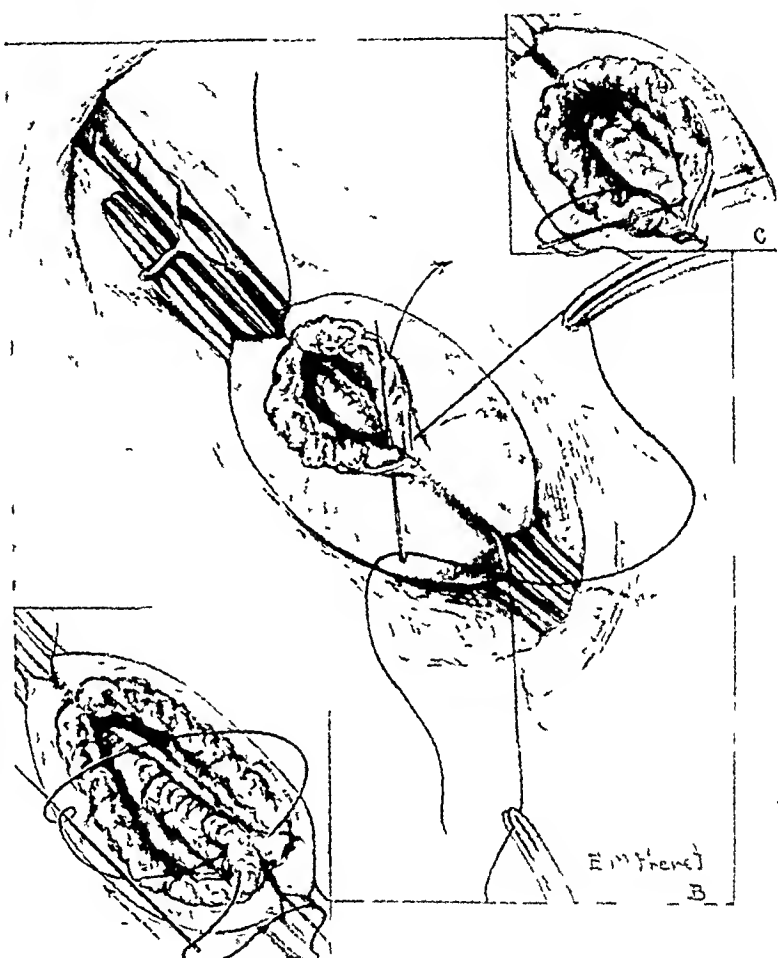


FIG. 6.—A double half hitch locks the stitch at the turn (insert A). The return stitch for the anterior half is exactly the same except that separate thrusts of the needle through each edge are necessary; the redundant mucous membrane serves the same purpose as on the posterior half. A sufficient amount of tissue must be included in each stitch to insure against cutting through. The tie is made to the end left long at the start. The outer tier of Lembert stitch is completed in the same way.

is important; the line is from greater curvature upward and to the left. Great care must be taken to see that the point nearest the greater curvature corresponds to the distal point on the jejunum. The jejunum is grasped about 3 inches from the duodeno-jejunal junction. The clamps are locked; all viscera except the portion in the grasp of the clamps, are replaced within the abdomen; and hot towels protect the wound beneath the clamps. A simple whipover suture of linen is used for the outer tier, the posterior half of which



FIG. 7—The cut edge of the opening in the meso colon is anchored to the stomach with interrupted plain catgut, care is taken that the distal point of the anastomosis corresponds to the low point (nearest the colon) of the opening of the meso-colon. This fixes and controls the position of the stomach, and the meso-colon drops over the suture line giving it additional protection.

first joins stomach and bowel wall for a length of $2\frac{1}{2}$ inches. Openings $1\frac{3}{4}$ inches long are then made in stomach and jejunum, escaping content being carefully caught on sponges.

No individual vessels are caught and the mucous membrane of both stomach and bowel is purposely left redundant. This insures perfect covering of the cut edges of stomach and duodenal walls; leaves no cracks into which gastric juice can seep, and is an important factor in the prevention of subsequent gastro-jejunal ulcer. The posterior half of the inner tier is then made with special tanned catgut, a simple continuous whip-over stitch, great care being taken to see that every stitch includes all

layers of stomach and gut walls; that spacing is accurate and tension constantly maintained, just enough for firm contact without blanching the tissues. Post-operative hemorrhage cannot occur if this suture is properly placed. A double half hitch to lock the suture is taken at the turn, and the same whip-over stitch is continued back completing the anterior half of the inner tier. Separate thrusts of the needle through each edge are necessary on this return stitch, and the same extreme care is taken with spacing, tension and mucous membrane edge approximation. The tie is made to the end of the same suture left long at the start. The anterior half of the linen outer tier stitch is then

completed. The stoma almost uniformly measures $1\frac{3}{4}$ inches in the clear and the outer line of suture $2\frac{1}{2}$ inches. The clamps are removed, and the low point of the edge of the opening in the transverse mesocolon, (*i.e.*, the point nearest the wall of the colon) is attached to the stomach wall at the distal end of the stoma, with interrupted fine catgut. Similar sutures complete the attachment of the edges of the mesocolic opening to the stomach. This step is important as it prevents herniation of the gut; allows the mesocolon to cover and protect the suture line, and maintains proper position of the stoma, which now lies vertically, the jejunum pointing directly downward, and swinging easily from side to side.

The belief that the stoma frequently contracts after gastro-enterostomy in cases in which the pylorus remains patent has long been disproven by X-ray studies made years after the operation in many cases. We believe that a painstaking technic with careful apposition of the cut edges of the mucous membrane which prevents open cracks in the suture line left to heal by granulation, does much to guard against the formation later of a contracting cicatricial ring.

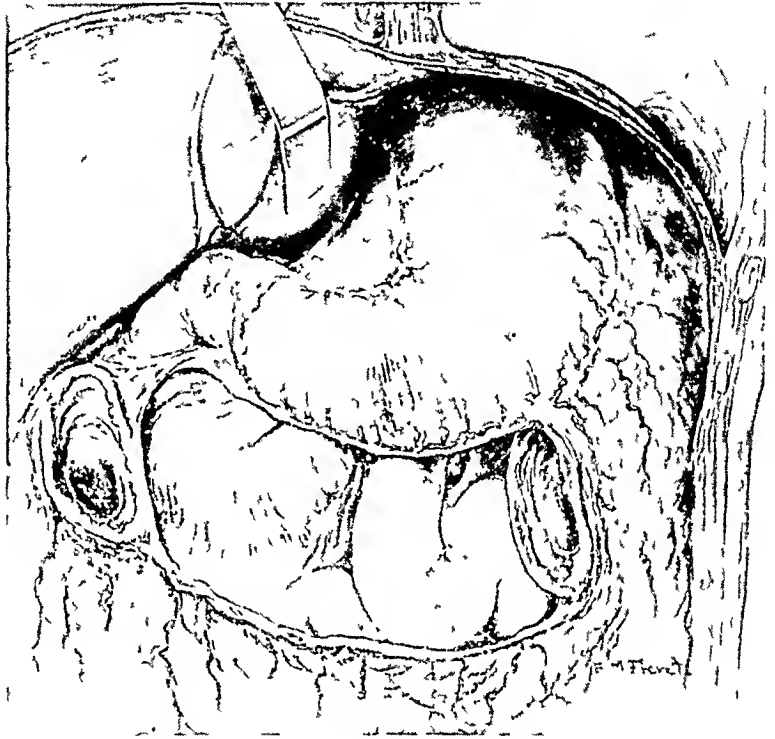


FIG. 8.—The stoma lies directly below the cardiac orifice and over the duodeno-jejunal junction, a little to the left of the midline. It swings easily from side to side as the stomach fills and empties.

We have had no case of post-operative hemorrhage in the series, a fact which adds to our feeling of confidence that the method of suture employed ensures complete hæmostasis. We believe that in the various types of running mattress stitch, vessels may be "jumped" and left to bleed in occasional instances. As far as we know there have been only two proven cases of marginal ulcer, and one suspected which did not come to secondary operation and later became symptom free. We repeat our belief that painstaking apposition of redundant mucous membrane edges safeguard appreciably against this condition.

We have had 196 cases of chronic duodenal ulcer excluding cases of acute perforation; 122 since 1915—in addition to seventy-four cases reported at that time, with sixteen deaths, a mortality of 8 per cent.

Gastro-enterostomy was done in 191 cases; pylorectomy in three; pyloric exclusion in one; simple excision in one.

Cholecystectomy was added in four cases.

The causes of death were:

	Cases
Post-operative pneumonia	8
Uræmia	2
Cerebral thrombosis	1
Pulmonary embolism	1
Diabetic coma	1
Vicious circle	1
Acute dilatation of stomach	1
Peritonitis, wound broke open	1

Half of the fatal cases were due to post-operative pneumonia. Of these two had cholecystectomy added to gastro-enterostomy, one of them having acute suppurative parotidites in addition to pneumonia; the other a feeble old man sixty-four years of age. In this latter case at least the added cholecystectomy was a fatal error in judgment. A third pneumonia case was a man of sixty-five with advanced chronic nephritis.

The two uræmia deaths were in men of advanced years, with chronic nephritis and alcoholism.

The cerebral thrombosis case occurred in a luetic man of fifty-nine years, who had had severe duodenal hemorrhage.

The diabetic coma in a known diabetic in whom stenosis was of a degree to threaten early death from starvation, a desperate risk deliberately taken.

Excluding pneumonia and the complication cited which are incident to any major operation, the deaths due to the operation *per se*, *i.e.*, peritonitis from breaking open of the wound; acute gastric dilation and vicious circle were only three in number.

There was no case of post-operative hemorrhage in the series and only three cases of vicious circle, two of which recovered after secondary operation.

One case came to secondary operation for gastro-jejunal ulcer, and one eight years after the gastro-enterostomy for persistent pain for a rigid stoma, not greatly contracted. Two others had pain suggestive of this condition, one of whom has cleared up, the other still has symptoms.

Two other patients have had more or less recurrent pain and indigestion. The two vicious circle cases subjected to secondary entero-enterostomy are now symptom free at seven years ten months, and three years ten months respectively.

The known post-operative morbidity in the series has therefore been relatively slight.

Chronic Gastric Ulcer.—Chronic gastric ulcer presents problems differing radically from those of duodenal ulcer. Eradication of the ulcer should be a part of whatever operative procedure is adopted. In many cases of ulcers of moderate size, especially in those not situated too near the pylorus we favor local excision or, destruction with the cautery, adding gastro-enterostomy.

The normal peristalsis of a stomach that has been the seat of ulcer is interfered with by the surrounding induration, and after excision by the cicatrix, and for this reason as one factor at least we believe that gastro-enterostomy added to excision gives better clinical results than excision alone.

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Gastro-enterostomy alone will fail to effect a cure of the ulcer in many instances, and the fear of malignancy, either present at the time of operation or as a possible later development cannot be set aside.

Excision or radical resection may, however, be impossible without great risk in large ulcers or those adherent posteriorly; with extensive peri-gastric adhesions, or in old and debilitated subjects. Gastro-enterostomy may be the best procedure available in such cases, and give excellent palliative results or sometimes even a cure. We once operated upon a woman seventy-eight years of age with a large posterior ulcer in the pyloric segment with relief of symptoms for more than two years.

In ulcers near the pylorus, partial gastrectomy is generally the best procedure if the patient's condition warrants; in ulcers of moderate size in the middle third, transgastric resection may give excellent results.

Hour-glass contraction due to ulcer calls for special procedures which we shall not attempt to discuss in this paper.

We have had since 1910, seventy-two cases of gastric ulcer treated by different methods, the results of which we shall not attempt to analyse, as it is a subject deserving detailed study beyond the limits of this paper.

SUMMARY

1. Surgical treatment of duodenal ulcer should not be resorted to until it is evident that the case is chronic and that medical treatment has failed to give adequate relief or to effect a cure.

2. The operation of choice should be simple gastro-enterostomy without pyloric exclusion. The more radical methods of resection should be reserved for cases with severe hemorrhage; those in which the simpler operations have failed to give relief or cases of gastro-jejunal ulcer.

Gastric ulcers, or cases in which the ulcer has invaded and passed the pylorus into the stomach wall are not considered in this summary.

3. A lasting clinical cure may be expected in at least 80 per cent. to 90 per cent. of cases treated by simple gastro-enterostomy.

THE PREVENTION OF ACUTE INTESTINAL OBSTRUCTION

ANALYSIS OF ONE HUNDRED CASES

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THE mortality of acute intestinal obstruction can be reduced only by the early recognition of the condition. Prompt diagnosis and early operation is the only way in which we can hope for a cure. After the toxæmia has spent its force, all else is nil. But the mortality of obstruction is as great to-day as it has been since the beginning of intestinal surgery, despite the progress in abdominal surgery. The toxæmia of the condition is still an unknown quantity in spite of the work that has been done in an attempt to find the cause of the toxic factor.

Most of the literature of this subject is written on the statistics, and the discussion of the toxæmia following the obstruction. Until the cause and the prevention or relief of the toxæmia shall be found, the mortality of the present time will likely continue.

In the ten years between nineteen hundred and thirteen and nineteen hundred and twenty-three, there were approximately one hundred and seven cases of acute intestinal obstruction diagnosed and treated as such at the Maryland University Hospital, by ten different men. From these I obtain the following statistics of importance. This group of cases does not include the strangulated herniæ save one case of strangulated obturator hernia, which was diagnosed as acute ileus following carbon monoxide poisoning.

Of the one hundred and seven cases, there were fifty-six deaths. To include the strangulated hernia of the corresponding time the mortality would be about forty per cent. rather than fifty-two per cent. This closely corresponds to the mortality of eight hundred and forty collected cases of Finney, Deaver, Ross and Flint. In this group I find four cases which were due to bands. There was no history of previous operation, in these cases but each gave a history of having had influenza of the gastro-intestinal type during the epidemic of the year nineteen hundred and eighteen.

The following table presents the location of the obstruction in these cases:

Obstruction in the ileum 68 cases.

Obstruction in the jejunum 19 cases

Obstruction in the colon 20 cases.

Obstruction due to volvulus in the big gut 1 case.

Obstruction due to volvulus in the small gut 7 cases.

Obstruction due to intussusception in the big gut 1 case.

Obstruction due to intussusception in the small gut 7 cases.

Obstruction due to bands and omentum 23 cases.

Obstruction due to plastic adhesions 38 cases.

Obstruction due to carcinoma of the colon 4 cases.

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Obstruction due to pregnancy	1 case.
Obstruction due to Meckel's diverticulum	4 cases.
Obstruction due to mesenteric cyst	1 case.
Obstruction due to mesenteric thrombosis (arterial)	5 cases.
Obstruction due to mesenteric thrombosis (venous)	1 case.
Obstruction due to tuberculous peritonitis	3 cases.
Obstruction due to foreign bodies	1 case.
Obstruction due to fecal impaction	5 cases.
Obstruction due to bands without previous operation	4 cases.
Obstruction due to obturator hernia	1 case.
Post-operative obstruction	46 cases.
Post-operative obstruction after incision and operation in the lower abdomen	34 cases.
Post-operative obstruction following rectus and midline incision	42 cases.
Post-operative obstruction following McBurney incision for appendicitis	4 cases.
Post-operative obstruction following drained rectus and midline incision	30 cases.
Post-operative obstruction following drained McBurney incision	2 cases.
Number of cases of gut resection.....	12 .....Mortality, 7 cases.
Number of cases of enterostomy.....	16 .....Mortality, 13 cases.
Largest amount of gut resected in any one case,	200 centimetres.

The literature contains many discussions on the proper treatment of acute obstruction both as to resection and enterostomy. This is a matter of choice for the individual operator and the individual case. It is a known fact that death is inevitable after absorption of a certain amount of toxin. The prognosis as Stone quotes may be guarded by the amount of non-protein nitrogen of the blood. Summers and Bonney believe the mortality in the cases of drainage of the gut can be reduced if the enterostomy is done in the jejunum. According to the report of the experiences, the fluid content of the gut is always found in the upper portion of the intestinal tract, while the gaseous matter is found in the ileum and large intestine.

The most impressive thought about the findings of this group of cases is, the question of drainage of the abdominal cavity for conditions other than obstruction *per se*. I believe this abdominal catastrophe might be prevented in a large number of cases by more conservative drainage of the peritoneum.

During the period of time from which this study was made there were approximately four to five thousand abdominal sections performed by various men in this hospital. Of course all cases of post-operative obstruction did not come back to this hospital for treatment, but I believe the statistics collected from the cases we have been able to study, will allow us to conclude to the point of argument, that the abdomen should not be drained though the rectus and midline incision. The rectus and midline incision in these several thousand cases was used about twice as frequently as the McBurney incision. But, in the findings we have forty-two mid-abdominal incisions, of which, thirty were drained, in comparison to four lateral incisions of McBurney, of which, two were drained. Draining the abdomen through the rectus and midline incision gives the coils of intestine a greater possibility of becoming obstructed, because loops of gut may encircle the drain tract, besides leaving at times an organized band free in the peritoneal cavity. In lateral drainage, as in the McBurney

incision where the drain is placed along the pelvic wall, coils of intestine are less likely to encircle the tubes or drain tract. If the peritoneal cavity is likened to a barrel it is better to drain away from the wall rather than drain through the middle of the cavity. The upper abdomen can be drained from the side by instituting drainage through the lateral wall as in the method of gall-bladder drainage of Greenough of Boston. Sub-phrenic abscesses of either side or sub-hepatic abscess can be drained with equal result by this route. Drainage of the lower abdomen is more likely to produce an obstruction because most of the small intestine is situated below the umbilicus, thereby making drainage more difficult.

Therefore in definite cases of acute appendicitis the McBurney incision is of choice, especially where drainage is necessary. We would go so far as to say that it is better to make a stab wound far out to the side where drainage is necessary after operations through the rectus and midline incisions and close the original wound. The time of convalescence would be no greater and the possibility of post-operative obstruction and hernia decreased.

While this is a study of a comparatively small group of cases, we believe it would hold good in a series of a large number of cases, thereby reducing the happening of this condition and reducing the mortality perhaps ten to fifteen per cent.

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THE TREATMENT OF ACUTE MECHANICAL INTESTINAL OBSTRUCTION BY HIGH TEMPORARY JEJUNOSTOMY*

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ACUTE mechanical intestinal obstruction has long been recognized to be a very serious condition accompanied by a high mortality. Even at present, in looking over case histories of this condition, the uniformity with which the diagnosis "acute intestinal obstruction" is followed by "end result, death" becomes very depressing and is a challenge to our ability and skill. For example, in our services in two of the hospitals in this city, within the past two years there have been a total of twelve histories filed under this diagnosis. Of these twelve cases only three recovered. The other nine died at times, varying from during the operation to as late as ten days afterwards. This list, of course, is unselected and comprises cases of all degrees of severity and duration of symptoms; but it is noteworthy that the three who recovered were among these on whom this procedure was not performed.

Ashhurst in 1890 collected 346 cases with a mortality of 69.3 per cent. The records of St. Thomas' Hospital, London, for the 20 years from 1886 to 1907, shows a total of 543 cases of intestinal obstruction with 319 deaths, a mortality of 58 per cent. Lenormant records his experience in 43 cases in which there were 20 deaths, a mortality of 67 per cent. (Quoted by Guillaume in *Occlusions de l'Intestin*, 1922).¹ Guillaume records 694 cases. Of those in which enterostomy alone was performed, 17½ per cent. died; those in which the operation consisted of release of the obstruction only, 48.2 per cent. died; those in which the operation consisted of release of the obstruction and enterostomy, 24.8 per cent. died. Thus there was the lowest mortality in the first group in which enterostomy alone was performed upon cases presumably offering the greatest surgical risk.

Pathology.—It has been shown beyond any doubt in many carefully conducted and brilliant researches, in which the names of Sweet, Draper, and Whipple² are so well known, that toxæmia is a constant and important element in intestinal obstruction; that the toxins are generated in the duodenum, probably from the pancreatic and biliary secretions, and that they are of the nature of proteoses. The further the obstruction is below the papilla of Vater the more diluted and harmless the toxins become. Costain³ has recently shown that the toxic material in intestinal obstruction and also in peritonitis is absorbed largely by the lymphatics; and that dogs with intestinal

* Read before the Joint Meeting of the New York Surgical Society and the Philadelphia Academy of Surgery, March 12, 1924.

obstruction and a fistula of the thoracic duct live much longer and recover more surely and promptly after the release of the obstruction than control dogs without such a fistula.

Indications for Treatment.—The indications for treatment in acute mechanical intestinal obstruction are (1) to remove the highly toxic bowel contents from the body as quickly as possible; (2) to relieve the distention which is paralyzing the intestinal musculature; (3) to restore the continuity of the intestinal lumen and reestablish the fecal current. We consider this to be the order of their importance.

Methods of Treatment.—Of the methods of treatment the most obvious is the relief of the mechanical obstruction, whatever its nature, bands, adhesions, volvulus, intussusception, strangulated hernia, or what not. This is sufficient to meet all indications if the patient is seen early—before 24 to 48 hours, while the general condition is still good. But in those distressingly frequent cases where symptoms have been present for a number of days, it is rarely enough. The intestinal muscles have become so paralyzed by distention and by the toxic intestinal contents that they are unable to pass these contents on to the anus rapidly and, therefore, continued absorption occurs. It may be several days before the strangulated segments of bowel, injured by prolonged pressure and anæmia, can recover their tone after a mechanical obstruction has been relieved and thus this mechanical obstruction is frequently succeeded by a paralytic ileus. Thus the simple relief of the mechanical obstruction too frequently fails to meet the prime indication of removing the toxic intestinal contents from the body. This is especially true in cases of long duration.

This insufficiency of mere relief of mechanical obstruction alone has been recognized for many years and various methods have been proposed to solve the problem. In 1908, Gibbon attempted drainage of the toxic intestinal contents by performing a jejunostomy with a Murphy button, and with the happiest primary results; but it was found impossible to permanently close the resulting jejunal fistula and the patient died of inanition. The excision of the strangulated segments with its contents and the subsequent anastomosis of the cut ends of the bowel has been proposed and practiced. This is a heroic procedure and would rarely be possible of accomplishment. Yet this treatment, serious as it is, has distinctly lowered the mortality in a series of cases on which it was tried. (Guillaume¹.)

Another method is continuous duodenal and jejunal drainage through a duodenal bucket and tube of small calibre. This is often very satisfactory as a temporary measure. It meets the indications very well, as it removes material from the point where it starts to accumulate and where its toxicity is the greatest, namely, the duodenum. It will at times tide over an apparently hopeless patient for a few days until he can undergo an operation with better chances of success. The disadvantage of the duodenal drainage is that it does not expose the pathology to the surgeon; it wastes valuable time if the patient is in condition to stand operation; and during this time the bowel may progress from a condition of strangulation to that of gangrene.

But there are many cases in which it will prove a life saving measure, and in our hands during the last five years we have felt that it has been a distinct asset in the treatment of intestinal obstruction of all kinds.

The method which we have adopted and recommend is not a new one. It was first proposed by Lennander⁴ in 1907. Charles H. Mayo⁵ again called attention to this method in 1922, as also did Guillaume.¹ It is simply a rapid high jejunostomy performed after the manner of a Witzel gastrostomy.

Technic.—The abdomen is opened and the obstruction released in whatever way seems best; in some cases it will be impossible to take the time either to find, or to reduce the obstruction. A distended coil of intestine is chosen as high in the jejunum as possible, and a good sized soft catheter—about 18 to 22 F.,—with its eye enlarged, is inserted through a hole made in the anti-mesenteric border of the intestinal wall into the lumen and held in place by a purse-string linen suture. The intestinal wall is then folded over the tube and held in place with a single layer of continuous Lembert sutures for a distance of three to four inches; thus the catheter is entirely covered over and buried in the wall of the bowel. The gut is sutured to the peritoneum at the lower angle of the abdominal incision and the abdomen is closed about the tube, and the tube is allowed to drain into a bottle.

After Treatment.—No special after treatment is necessary except to keep the tube patent. It sometimes becomes clogged with solid particles but these can be cleared away by irrigation. In one of our cases the bowel angulated at the proximal end of the catheter from lack of muscle tone but this condition was readily overcome by introducing several ounces of fluid through the catheter into the bowel. After the bowels are moving freely, which should happen within forty-eight hours after jejunostomy, and convalescence is established, the tube is removed and the tract allowed to close. We have had no trouble with the failure of the tract to close and do not anticipate any. Several days will elapse before the tube is removed and during this time protective adhesions will have formed which will prevent leakage from the tract into the peritoneal cavity. When the tube is finally removed, from the third to the seventh day, there is left in the intestinal wall a long canal which is lined with endothelium, and which is constantly kept collapsed by intrainstestinal pressure. Very little if any irritating intestinal contents enter this canal after the withdrawal of the catheter and the walls rapidly adhere and coalesce. There is practically no drainage from the time the catheter is removed and the wound has in our experience always healed kindly. We believe that to the use of this procedure two of the subjoined patients owe their lives, while another was brought to a condition where he might have been permanently cured if proper advantage had been taken of the opportunity.

In favor of this procedure we feel that it can be used in any case where operation is possible. There are practically no contra-indications. It is rapid. Alone, it meets the urgent indications but, of course, should be combined with coincident relief of the obstruction if possible. It will, however, sometimes

tide over a patient and improve his condition until a more radical operation can be done, in the same way that the condition of an old prostatic patient will improve after drainage of the bladder has been established by suprapubic cystostomy.

Sir William Taylor⁶ gives three classes of cases of acute intestinal obstruction based upon the duration of the symptoms. (1) Under 24 hours, the general condition being favorable, relief of obstruction is all that is required. (2) From 1 to 3 or 4 days, when the general condition is usually fair, there may be stercoraceous vomiting. These patients will usually stand relief of obstruction but jejunostomy as a primary procedure should always be done. (3) Those cases in which the mechanical obstruction has existed for longer than 4 days and in which the general condition is usually poor. Here primary operative interference should be limited to a rapid high jejunostomy. Taylor also advises lavage of the intestines with sodium bicarbonate through the jejunostomy tube. With this classification and recommendation as to operation we thoroughly agree though we have not felt or encountered the necessity for routine intestinal lavage as suggested by Taylor. If we could receive more of our patients in classes 1 and 2 on admission we feel we should not have to confess to a mortality of nearly 75 per cent.

Illustrative Cases.—In support of these contentions we wish to refer to the following case abstracts.

CASE I.—M. R., Germantown Hospital No. 3122-1922, No. 2092-1922, a colored woman, age thirty-two years. Duration of mechanical obstructive symptoms, seven days. General condition at time of operation very poor. Pathological condition found:—There was a band of adhesions from the intestines to the scar of a former operative incision, around which a loop of gut had become twisted. Operative procedure—resection of the obstructing band with untwisting of the volvulus. Course—the day after operation the bowels moved three times, then the obstruction gradually recurred and finally became complete. Her general condition slowly declined in spite of duodenal drainage; and eight days after the first operation she was again operated upon and this time her condition was more critical than at the first operation. Second operation—no exploration. A rapid high jejunostomy was done. Course—there was immediate and profuse drainage from the jejunostomy tube and she made an uninterrupted recovery. Her bowels moved twelve hours after the jejunostomy and during the first twenty-four hours she had no less than 12 bowel movements. The tube was removed at the end of the seventh day and the wound was closed at the end of the fourteenth day. This was one of our earliest cases. We feel now that it was a mistake not to have performed a high jejunostomy at the time of the primary operation when the mechanical obstruction was relieved.

CASE II.—Pennsylvania Hospital No. 2493-1923. D. R., an adult colored woman, twenty-eight years of age. Two years before admission she had been operated upon and a bilateral salpingo-oöphorectomy was done in another hospital. On admission there were symptoms of complete intestinal obstruction which had been present for five days and her general condition was very unfavorable. Pathological condition found at operation—a loop of bowel was adherent to the right broad ligament, forming a pocket through which another loop of bowel had become strangulated. Operative procedure—exploration, and inspection of the entire intestinal canal. Relief of the obstruction high jejunostomy. During the operation respiration and bleeding from

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the cut surface ceased. Artificial respiration and stimulation were given and the patient responded. Post-operative course—drainage was profuse within several hours after the jejunostomy was performed. Convalescence—the bowels moved the following day. The tube was removed on the fifth day and the wound closed on the twelfth day. Three months after operation, she had an attack of vomiting and some abdominal pain but was not reoperated upon and entirely recovered from these symptoms. Aside from this she has been in excellent health since the last operation.

CASE III.—Pennsylvania Hospital No. 270-1924, P. D., a middle aged white laborer. entered the hospital with symptoms of acute abdominal catastrophe of twenty-four hours duration. General condition at time of operation was poor. Very slow pulse and subnormal temperature. Pathological condition found.—There was gangrene of the entire descending colon starting at the splenic flexure and extending to the rectum. Operative procedure.—A colostomy in the transverse colon was performed after the manner of a jejunostomy. Course.—The general condition was not improved. Drainage was scanty. On the second day the patient pulled out the tube. Immediate reoperation was done and this time a high jejunostomy. Course.—For a number of days his condition improved in a remarkable manner. The drainage was profuse within several hours after performing the jejunostomy. He had an excellent appetite. He had bowel movements from the rectum, first with an enema and then voluntarily. On the eighth day the tube was removed. Following the removal of the tube his condition rapidly grew worse and he died on the tenth day after the primary operation. Autopsy.—The entire gangrenous portion of the colon had sloughed away, and there was a general peritonitis present. Two mistakes were made in the treatment of this case. The first was in making the enterostomy in the transverse colon instead of high in the jejunum; in the second place when the patient's condition had improved so markedly and so unexpectedly, the opportunity of resecting the known gangrenous descending colon was missed; and if this had not been possible, it certainly would have been feasible to have performed a permanent colostomy in the ascending colon proximal to the gangrenous descending colon.

CASE IV.—Germantown Hospital No. 2716-1923. J. Y., a business man, forty-eight years of age, sick for two days with symptoms diagnosed as intestinal obstruction by the surgeon and as acute appendicitis by the physician, Dr. H. B. Wilmer, was operated upon October 27, 1923, and a gangrenous perforated appendix was found in the pelvis. A pelvic peritonitis was present and the abscess was drained. The location of the abscess with adhesions between the cæcum and adjacent coils of small intestines explained the intestinal obstruction which had confused us. He made a fairly good recovery but there was some tendency to distention. On November 6th his duodenum was drained for several days because of vomiting and though this relieved him, unfortunately, at this period he developed signs of a consolidation in the right lung and he passed through a frank lobar pneumonia which resolved by crisis on the sixth day. The cause of the pneumonia was probably a septic pulmonary embolus. On November 22nd he again began to vomit and his bowels failed to move. On the 24th complete intestinal obstruction had developed and a high jejunostomy was done in the middle of the night—no exploration of the abdominal cavity was attempted. The following day the jejunostomy tube was draining freely and he had a bowel movement. On the 26th the tube became clogged and vomiting again occurred. The clogging of the tube at this time we felt was due to an angulation of the paralyzed bowel at the tip of the catheter. The catheter was withdrawn after injecting several ounces of fluid into the bowel and vomiting immediately stopped. After an interval of an hour the catheter was reinserted and drainage reestablished. From this time on there were no more obstructive symptoms. He was discharged convalescent on December 22, 1923, and he has had no symptoms of obstruction at the time of writing, which was four months later. Pathology.—At the first operation, acute gangrenous appendicitis with partial obstruction and pelvic peritonitis. At the second, no exploration was per-

formed on account of the very poor general condition, but part of the intestines were distended and other parts collapsed. The obstruction was doubtless due to adhesions and impaired muscular tone, a result of his pneumonia and prolonged illness. The history of this case is given at some detail because in some respects it is the most remarkable in the series and records a most extraordinary recovery from many complications—three definite attacks of acute mechanical intestinal obstruction.

Conclusions.—1. The cause of death in acute mechanical intestinal obstruction is toxæmia from absorption of toxic intestinal contents.

2. The indications for the surgical treatment of acute mechanical intestinal obstruction are in the order of their importance (1) to eliminate the toxic material from the body as rapidly as possible; (2) to relieve the bowel from the distention which paralyzes it; (3) to restore the lumen of the intestines and to reestablish the fecal current.

3. Of the various methods suggested to meet these indications we feel that a high jejunostomy performed with a rubber tube after the technic of a Witzel gastrostomy is the most satisfactory procedure.

4. The procedure should be used, alone or in combination with other procedures, in all cases of acute mechanical intestinal obstruction of over twenty-four hours duration which are submitted to operation.

5. The stoma left on the withdrawal of the rubber tube closes promptly when the need for it has passed.

6. This method when used as a temporary expedient will at times allow an apparently hopeless patient to improve to such an extent that more radical procedures may be attempted later when there is some hope of success.

REFERENCES

- ¹ Guillaume: Occlusions de l' Intestin, 1922, Maury: ANNALS OF SURGERY, Oct., 1907.
- ² Numerous Articles by Draper, Sweet and Whipple.
- ³ Costain: Surg., Gyn. Obst., 1924, vol. xxxviii, p. 252.
- ⁴ Lennander: Deutsch. Ztschr. f. Chirurg., 1907, vol. lxxxvi.
- ⁵ Mayo, C. H.: Mayo Clinic, vol., 1922.
- ⁶ Taylor: Surg., Gyn. Obst., 1924, vol. xxxviii, p. 252.

PERFORATED GUNSHOT AND STAB WOUNDS OF THE ABDOMEN

TREATED AT THE GOUVERNEUR HOSPITAL OF NEW YORK

BY WOODHULL LEE CONDUCT, M.D.
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A REVIEW of the records of Gouverneur Hospital of New York City, from March 11, 1911 to August 31, 1922—a period of eleven and one-half years—shows that seventy-nine cases of gunshot and stab wounds of the abdomen were admitted. In this review twenty-seven cases have been excluded because of the lack of evidence of perforation of the peritoneal cavity. Of the remaining fifty-two cases, twenty were gunshot perforations, and thirty-two stab wounds. Of the twenty gunshot wounds there were eleven recoveries and nine deaths, giving a mortality of 45 per cent. and of the stab wounds there were twenty-three recoveries and nine deaths, giving a mortality of 28 per cent. The ages of the patients varied from six to fifty years. There were forty-nine males and three females. The time elapsing from the receipt of injury to the operation varied from one-half to twenty-four hours, with an average of slightly over two hours. The fifty-two cases were operated on by nine different visiting surgeons.

CASE I.—March 26, 1911. J. M., male, Italian, thirty-eight years, laborer. Patient was shot in the abdomen and operated on two hours after admission to hospital. When the peritoneal cavity was opened, there was a large amount of fluid and clotted blood. There were three perforations through the ileum and jejunum, a perforation of the mesentery and a bruising of the transverse colon. This case died four hours after admission of shock and hemorrhage. Autopsy showed no further hemorrhage or leakage through the suture line.

CASE II.—May 2, 1911. N. S., male, Russian, nineteen years, newsboy. This boy was stabbed in the abdomen and operated on seven hours after the injury. An incision was made through the wound and protruding omentum returned. Exploration showed the viscera uninjured. Recovery.

CASE III.—June 29, 1911. W. C., U. S., twenty-three, male, driver. Laparotomy was done one hour and fifteen minutes after a gunshot wound, but no viscera were found injured, with the exception of a small contusion of the serous coat of the small intestine. Cured.

CASE IV.—January 25, 1912. Name, nativity, race, unknown. Male. Gunshot wound of the abdomen, no operation performed, died one-half hour after admission to hospital from shock and hemorrhage. No autopsy.

CASE V.—March 10, 1912. D. M., Irish, forty, male, occupation unknown. Patient was admitted to hospital two hours after a gunshot injury and exploration showed one perforation of the omentum with no other visceral injury. Drainage. Recovery.

CASE VI.—June 16, 1912. H. W., nativity, and occupation unknown, fifty years, male. Operation showed two perforations of the cardiac end of the stomach, a long wound of the liver, running from the right to the left lobe. Death within eighteen hours due to shock and hemorrhage. Autopsy showed both lungs collapsed with a hæmopneumothorax.

CASE VII.—August 2, 1912. B. G., U. S., twenty-two, male, salesman. Admitted

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to hospital after a gunshot wound of the abdomen, lung and right thigh. At operation a large laceration of the liver was found. Liver wound packed. Recovery.

CASE VIII.—February 20, 1913. I. L., Russian, thirty-five, male, sailor. Admitted to hospital after a stab wound of the abdomen, with omentum protruding, and some intestine. Operated on one-half hour after admission. Patient had a complete evisceration and died on the ninth day of general peritonitis. No autopsy.

CASE IX.—May 14, 1913. J. K., U. S., twenty-nine, male, laborer. Operated on one-half hour after admission for gunshot wound. At operation there were two bullet wounds of the stomach, and one perforation of the liver and pancreas. Died on fourth day apparently of peritonitis. No autopsy.

CASE X.—June 1, 1913. T. A., Russian, forty-eight, male, laborer. Stab wound with omentum protruding. Operated on under spinal anaesthesia. No visceral injury found. Recovery.

CASE XI.—August 9, 1913. T. S., Italian, thirty-four, male, laborer. Gunshot wound of the abdomen. Operated on three hours after injury, two small perforations of the small intestine and rupture of the spleen, suture of the intestines and splenectomy, drainage. Recovery.

CASE XII.—August 15, 1913. M. B., U. S., twenty-two, male, printer. Stab wound of the abdomen with small intestine protruding and laceration of the arm. No visceral injury, drainage. Recovery.

CASE XIII.—August 31, 1913. F. C., Italian, nineteen, male. Gunshot wound of the abdomen, operated on soon after admission two perforations in the lower end of ileum, opposite each other necessitating an 8 inch resection with an end-to-end anastomosis and drainage. On the fourth day operated on for intestinal obstruction and a perforated bowel found. Sixth day, death from general peritonitis. No autopsy.

CASE XIV.—October 13, 1913. E. L., Italian, twenty-one, male. Stab wound of the abdomen. Operated on shortly after admission and stab wound of the liver closed with mattress suture of silk, drainage, death. No autopsy.

CASE XV.—May 1, 1914. A. K., Russian, thirty-four, male, special officer. Stab wound. No operation done, recovery. Pathology unknown.

CASE XVI.—August 27, 1914. J. L., U. S., twenty-nine, male, machinist. Operated on five hours after a stab wound of the abdomen with a piece of omentum protruding. Because of acute alcoholism this case was done under local anaesthesia. Death on fourth day. No autopsy.

CASE XVII.—December 5, 1914. M. S., Russian, fourteen, male, school boy. Stab wound of the abdomen, operated on three and a half hours after admission, omentum protruding, small amount of hemorrhage with a small hole in the stomach. Recovery.

CASE XVIII.—September 15, 1915. J. C., Irish, thirty-four, male, driver. Stab wound operated on one hour later, protruding omentum no viscera injured. Complications, stab wounds of chest and arm. Death on fourth day from peritonitis, no autopsy.

CASE XIX.—October 6, 1915. F. D., Italian, thirty, male, laborer. Stab wound with omentum protruding operated on fifty minutes later, no visceral injury.

CASE XX.—January 18, 1915. M. P., Russian, twenty-one, male, tailor. Suicide. Gunshot wound of the abdomen, operated on three hours later, two holes in stomach, one in the colon, and a large rent in the mesentery with a wound of the kidney. This case is of special interest as there was only one kidney of the horseshoe type. On the eighth day he was given solid food by his relatives, death on the ninth day from embolism. No autopsy.

CASE XXI.—April 23, 1915. L. M., Italian, thirty, male, operator. Gunshot wound of right arm and leg and abdomen. At operation shortly after admission there were eight perforations of the intestine, necessitating a six inch resection in which five perforations were found. Almost complete obstruction followed and frequent lavage

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was done. On the forty-first day the Murphy button which was used in the suture was removed. Recovery.

CASE XXII.—January 19, 1916. S. S., Russian, twenty-seven, male, presser. Stab wound of the abdomen with omentum protruding, operated on two hours after admission, no visceral injury. Died immediately after operation. No autopsy.

CASE XXIII.—January 1, 1917. A. H., U. S., twenty-two, male. Gunshot wound of the abdomen, laparotomy soon after admission, two perforations through ileum and mesentery, general peritonitis, suture, drainage. Recovery.

CASE XXIV.—March 14, 1917. A. V., Italian, thirty-one, male, operator. Multiple stab wounds of head, face and abdomen. Three-quarter inch laceration of anterior wall of stomach, sutured, drainage. Recovery.

CASE XXV.—April 8, 1917. A. B., Italian, twenty-four, male, chauffer. Operated on for stab wound of the abdomen six hours after injury. Laceration of omentum, no visceral injury, drainage. Recovery.

CASE XXVI.—July 4, 1917. F. T., Italian, nineteen, female, operator. Fell off a chair onto scissors which perforated the abdomen. At operation one hour after admission there was a lacerated wound of the ileum, colon and the inferior vena cava. The abdomen was full of blood, suture of vena cava, with linen purse-string and closure of the intestine. Recovery.

CASE XXVII.—August 22, 1917. F. V., Italian, sixteen, male, clerk. Stabbed in abdomen twenty-four hours before operation. There was a perforation found in the gall-bladder and common bile duct. No attempt at suture was made, drainage. Recovery.

CASE XXVIII.—June 2, 1918. Italian, male. Stab wound of abdomen, operated on soon after admission, perforation of transverse colon with fecal matter in the abdomen. Suture, drainage. Death. No autopsy.

CASE XXIX.—September 6, 1919. E. W., Austrian, twenty-four, male, milliner. Stab wound of the abdomen, operated on three and a half hours after injury, small blood-vessel severed, no visceral injury, drainage. Recovery.

CASE XXX.—September 21, 1918. J. G., German, forty-four, male, kitchen man. Laceration of scalp, lip, tongue and stab wound of the abdomen with omentum protruding. Operated on three and a half hours after injury. Laceration anterior wall of stomach near cardia. Suture, drainage. Death on fifth day. Peritonitis. No autopsy.

CASE XXXI.—April 27, 1919. A. S., Italian, thirty-one, male, barber. Stab wound of the abdomen. Operated on soon after admission, rupture of the liver. Packed, drained. Recovery.

CASE XXXII.—August 17, 1919. J. M., Italian, twenty-one, male, laborer. Operated on six hours after a stab wound, laceration of omentum, no visceral injury, suture of omentum, drainage. Recovery.

CASE XXXIII.—December 3, 1919. M. J., Russian, eighteen, female. Bullet wound of liver, into right lobe, operated on one hour after admission, packed, drainage. Complications, pneumonia. Double suppurative otitis media. Recovery.

CASE XXXIV.—February 20, 1920. J. D., Irish, thirty-two, male, laborer. Gunshot wound of the liver operated on one hour later, packing, drainage. Recovery.

CASE XXXV.—April 17, 1920. S. K., U. S., twelve, male, school boy. Gunshot wound of liver and kidney, right lumbar nephrectomy, drainage, packing. Death ten hours later from hemorrhage. No autopsy.

CASE XXXVI.—June 29, 1920. H. L., Austrian, twenty-four, male, laborer. Stab wound of liver. Operated on one hour later. Suture of liver, drainage. Recovery.

CASE XXXVII.—July 26, 1920. T. K., Russian, twenty-seven, male, longshoreman. Operated on two hours after a gunshot wound in abdomen, seven perforations of small intestine. Enterorrhaphy. Drainage. Recovery.

CASE XXXVIII.—July 27, 1920. J. G., Irish, thirty, male, laborer. Gunshot wound of liver, two hours after, suture of liver, complicated by fracture of rib and severe hemorrhage. Died within forty-eight hours. No autopsy.

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CASE XXXIX.—December 13, 1920. M. S., Russian, thirty-five, male, laborer. Stab wound of abdomen, omentum protruding. Operation one and one-half hours after injury, perforation of stomach, suture, six weeks later secondary closure. Recovery.

CASE XL.—December 28, 1920. S. K., U. S., eight, male, school boy. Stab wound of abdomen. Operated on three hours after injury, perforation of stomach and omentum. Suture, drainage. Recovery.

CASE XLI.—April 13, 1921. J. J., Russian, twenty-nine, male, laborer. Stab wound of left lobe of liver. Operated upon soon after injury, suture, drainage. Recovery.

CASE XLII.—May 24, 1921. J. B., Russian, thirty-eight, male, peddler. Stab wound, operation two hours later, omentum protruding, no visceral injury, complication pneumonia. Recovery.

CASE XLIII.—June 14, 1921. I. F., U. S., twenty, male, peddler. Stab wound of stomach, two hours later repair, drainage. Recovery.

CASE XLIV.—August 18, 1921. L. L., Roumanian, twenty-three, male, student. Stab wound of the stomach, perforation of anterior wall of stomach. Suture. General peritonitis. Death on fourth day. No autopsy.

CASE XLV.—August 25, 1921. P. K., U. S., thirty-seven, male, chauffeur. Stab wound of spleen, drainage, no suture. Recovery.

CASE XLVI.—August 28, 1921. S. N., Polish, thirty-six, male, sailor. Stab wound of left chest, wrist, thigh and abdomen, omentum protruding, no visceral injury, drainage. Recovery.

CASE XLVII.—May 31, 1920. G. M., Irish, thirty-one, male. Stab wound of abdomen, with division of epigastric vessels, negative for visceral injury. Drainage. Recovery.

CASE XLVIII.—November 21, 1921. H. G., U. S., thirty-nine, male, jobber. One hour and a half after stab wound, five perforations of jejunum, perforation of transverse colon, perforation of mesentery, fifty-four inch resection of jejunum with end-to-end anastomosis with Murphy button. Recovery.

CASE XLIX.—January 16, 1922. A. D., Russian, twenty-four, male, seamen. Gunshot wound of abdomen, immediately after operation. Laceration of liver, and right kidney. Suture of liver. Right nephrectomy, counter stab wound for drainage. Recovery.

CASE L.—January 17, 1922. U. S., six, female, school girl. Gunshot wound of abdomen, one hour after injury, ten perforations were found in the ileum and three feet of intestine resected. Died twelve hours after operation of shock, no autopsy.

CASE LI.—March 11, 1922. M. C., twenty-one, male, bullet wound of abdomen. One hour after injury, double perforation of sigmoid, two double perforations of ileum, and perforation of jejunum. Eight inch resection of ileum, end-to-end anastomosis, five inches from the ligament of Treitz. Drainage. Recovery.

CASE LII.—August 13, 1922. W. W., thirty-five, male, barber. Stab wound of abdomen and chest near the heart. Two hours after injury operation. Small intestine protruding, mesentery lacerated, mesentery sutured, drainage, complication pleurisy, following pneumonia, and death on the fourth day. No autopsy.

Reference to the literature on the subject reveals a large number of articles from various hospitals and numerous reports from military surgeons on the field of battle and emergency hospitals behind the lines. During the Civil War the mortality was 90 per cent. In the Boer War about 40 per cent. without operation. This may be explained by the existence of only one or more small perforations with a bowel fairly empty as often seen in a soldier in the field. Fenner in the ANNALS OF SURGERY, 1902, reports 152 cases from the Charity Hospital in New Orleans, of which 96 were gunshot wounds with visceral injury. Of these 71 died; a mortality of 74 per cent.

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Winslow reports 31 cases of stab and gunshot wounds over a period of five years seven months in the *Surgery, Gynecology and Obstetrics*, May, 1922, taken from the University Hospital in Baltimore; in these cases the mortality was just under 50 per cent., in the stab cases it was 25 per cent. and in the gunshot wounds 50.5 per cent.

In summing up the Gouverneur Hospital Series the mesentery was perforated four times, the omentum five times and the inferior vena cava once. Omentum was found protruding from the abdomen five times and the intestine three times. Of the wounds of the hollow organs there was one of the gall-bladder and common bile duct, ten of the stomach, two of the descending colon, two of the transverse colon and one of the sigmoid, six of the jejunum and six of the ileum.

Of the solid organs there was one perforation of the pancreas, only two perforations of the spleen, three of the kidney and twelve of the liver. In no case, in this series, were the pelvic organs or the bladder involved. In only one instance in the series was a perforation overlooked at operation and found at autopsy and this case was an exceedingly difficult one—inasmuch as five other perforations were found.

In the last twenty-five years, or since the time of the Spanish-American War, but little advance has been made towards lowering the mortality in gunshot and stab wounds of the abdomen. All surgeons are agreed that immediate operation following injury offers the best results, although from time to time, as in one case of this series, recoveries have taken place without operation.

In an article appearing in the *ANNALS OF SURGERY*, issue of September, 1923, by Mason of Birmingham, Ala., in analyzing sixty-nine cases of "The influence of Hemorrhage on Mortality in Gunshot wounds and other injuries of the Abdomen," he lays great stress upon the feature of hemorrhage, and classifies his cases into a large hemorrhage series, with a mortality of 88.8 per cent. against a small hemorrhage series with a mortality of 31.5 per cent. He urges a more extensive employment of transfusion and suggests that auto-transfusion should be practiced in selected cases.

Certainly these perforated gunshot and stab wounds of the abdomen have furnished considerable food for thought to the surgical profession in the past and will continue to do so in the future. Possibly local anæsthesia would be a factor in lowering pulmonary complications. Since it is impossible to tell just what damage an instrument penetrating the abdominal wall has done, immediate laparotomy offers the greatest chance to the patient with a complete evisceration and thorough examination of all organs.

APPENDICEAL FECAL FISTULA*

BY JOHN B. DEAVER, M.D.

OF PHILADELPHIA, PA.

APPENDICEAL fecal fistula is one of our more or less constant companions in the Lankenau Clinic, and no doubt also in other hospitals, where a great many operations for acute appendicitis are performed. Pathologically speaking, the present classification of appendicitis may be correct, but for clinical purposes it is too complicated, and what is more important, it is not practical, since these distinctions cannot be made at the bedside with any certainty. In the Lankenau Clinic we make the general classification of chronic and acute appendicitis since we find that practically all cases of acute appendicitis are partially or entirely gangrenous. That is to say, when the acute appendix is laid open the mucosa will be seen to present gangrenous areas or to be gangrenous throughout while often the entire appendix is gangrenous. Where the gangrenous area is large or involves most, if not all, of the mucosa, it is not uncommon for the patient to have a severe chill associated with the other familiar symptoms. I am frequently asked what is the significance of a chill in appendicitis; the foregoing is the answer. A chill may also be due to a thrombophlebitis of the veins of the mesoappendix and of those into which they empty. The late Dr. A. G. Gerster called attention to the possibility of a purulent pyelophlebitis the result of appendicitis, when he remarked that the occurrence of a chill is of the greatest import, and should be considered to constitute a more urgent indication for operation than even the signs of local peritonitis. I am also frequently asked why some cases of acute appendicitis have pain in the left side. The answer is that the appendix in such cases occupies the pelvis or lies beneath the terminal mesentery and points upward and to the left. It may be interesting to consider the different positions in which the appendix is apt to be located. The two most common positions are retrocaecal and retrocolic, when it frequently extends as high up as the gall-bladder, and the pelvic or descending position; other positions in the order of frequency are: Subcaecal, anterior to the terminal ileum, or pre-ilial and posterior to the terminal post-ilial or splenic, pointing in the direction of the spleen.

The complication of appendicitis by fecal fistula is one peculiarly confined to the case presenting perforation, abscess and drainage. The last 200 cases of appendiceal fecal fistula in the Lankenau Clinic occurred among a series of 4063 cases of acute appendicitis, an incidence of approximately five per cent. In every instance more or less pus was present at the primary operation and required drainage either with gauze, cigarette drains or glass tubes. In the vast majority of cases some ulceration of the caecum or terminal ileum was noted at the primary operation. The cases which showed perforation at the base of the

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appendix displayed a peculiar tendency to the formation of a fecal fistula owing to the amount of inflammatory reaction and the friability of the tissues which must be relied upon for turning in the stump.

Of the 200 fistulas 74, or 37 per cent., healed spontaneously, while 97, or 48.5 per cent., required operative repair. The remainder, 29, or 14.5 per cent., left the hospital, having refused operation, or were sent home to recuperate, and to return later for operation, but failed to do so. No doubt a certain proportion of these latter closed spontaneously later on and can therefore be included among that number.

The longest duration of fecal drainage before operative relief was sought was in a patient who had had an intermittent discharge for seven years; while the shortest duration of the fistula was a case which closed spontaneously in twelve hours. As a rule, a period of trial for possible spontaneous closure was permitted to pass, before deciding to operate, the length of time depending upon the general physical condition, the amount and character of the drainage, and the mental attitude of the patient.

The type of operation for repair of the fistula depended, of course, upon the conditions existent at the time. In 60 per cent. of the cases, simple inversion of the fistulous opening by a purse-string linen suture, reinforced by an additional suture line, was all the surgery required. In 15 per cent. the condition of the bowel surrounding the fistula was such as to excite doubt as to its regenerative power in the presence of the usual fecal stream, so that an ileocolostomy was performed to short-circuit the affected bowel, after inversion and reinforcement of the fistula. The site of the anastomosis was usually from a convenient point near the terminal ileum to the transverse colon. Twenty-three per cent. of the cases presented either multiple fistulas or else the fistula was so large as to preclude closure with maintenance of the lumen of the bowel surrounding the fistula, so that hope for the recovery of this portion of the bowel had to be abandoned. These required resection of the bowel, varying from a small portion of the cæcum to resection of a foot or more of the terminal ileum with the cæcum and entire ascending colon. Ileocolostomy was of course the last stage of the operation.

Eighty of the 97 operated cases recovered and were discharged perfectly healed. In eight instances there was a recurrence of fistula, while nine cases died after operation, from shock, cardiac failure or other causes.

Nature alone then was able to heal 37 per cent. of cases, but in nearly 50 per cent. she needed the timely aid of the scalpel and the needle, after which 80 per cent. of these latter joined the ranks of the sound in body, having successfully turned back the insidious attacks of the insidious appendix.

I have to thank Dr. Maurice P. Charnock, one of my senior surgeons in the Lankenau Hospital, for collecting the data which made this discussion possible.

FURTHER STUDY OF CYSTS OF THE SPLEEN

By ROYALE H. FOWLER, M.D.

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THE first study, by the writer entitled "Non-parasitic Cysts of the Spleen", was published in 1910, a second appeared in 1913 (*ANNALS OF SURGERY*, vol. lvii, p. 658) and a third article "Surgery of Cysts of the Spleen" followed in 1921, (*ANNALS OF SURGERY*, vol. lxxiv, p. 20). In these contributions all cases appearing in the literature were collected and reviewed. Especial attention was given to nosology, pathogenesis, pathology and surgical treatment. An intensive effort was directed toward cornering the knowledge of these phrases.

The writer's review up to December 31, 1921, is summarized as follows:

1. There are two cases of dermoid cysts reported.
2. There are ninety recorded cases of non-parasitic cysts of the spleen which represent a variety of types due to various causes. Non-parasitic cysts are most common in women during the child-bearing period. Pregnancy and antecedent disease of the spleen can be evoked for minor contributing rôles. Trauma plays the most important rôle in the single, large unilocular so-called hemorrhagic or serous types; the latter may develop from the former by liquefaction of solid contents or the hemorrhagic types may be caused by the occurrence of secondary hemorrhage into the serous variety. The influence of a twisted pedicle, embolism and disease of intrasplenic blood-vessels cannot be denied. In the case of multiple cysts, inclusions of misplaced cellular nests (endothelium of the peritoneum or cells of origin of lymphatic spaces or vessels), during the developmental period or as a result in later life, of traumatic or spontaneous rupture of the capsule or of perisplenitis, may result in multiple cysts of the serous or lymphatic variety. Fifty-eight cases of non-parasitic cysts have been treated surgically, eight by puncture, fourteen by incision and drainage, six by excision or partial splenectomy and thirty by splenectomy. The latter is usually the method of choice.
3. Echinococcus cysts occur in two forms single and multiple; solitary cysts are rare. The combined statistics of Thomas, Mosler, Fehleissen, Coen and Tinkler indicate a possible total of 191 cases of parasitic cysts up to 1894. Johnston collected from Bessel-Hagen's series 15 splenectomized cases of hydatid disease up to 1900 with four deaths. He added 8 additional cases with no deaths. The mortality for these 23 splenectomized cases is about 17 per cent. According to Finklestein there have been 46 cases of echinococcus cysts subjected to splenectomy up to 1909, with eight deaths to which may be added two cases of Sherren and Hitzrot (unpublished) without mortality. The operative death rate for 48 splenectomized cases is about 15 per cent.
4. True neo-formative cysts (lymphangioma, hæmangioma) are not common.

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Non-parasitic Cysts.—Morphologically these can be divided into two main groups which are of especial clinical interest. 1. Single with serous or bloody contents, usually large. A large number in this group are more properly designated encysted hæmatoma and are of traumatic origin. 2. Multiple, fused and of varied origin still undetermined. These may be designated polycystic disease (Coenen-Fowler).

The classification based on pathogenesis submitted by the writer in 1921 has received favorable comment, but it is felt that much is still to be desired. It is believed that the following classification is rather more inclusive and will further improve our understanding.

1. Traumatic cysts.

(a) Usually large and unilocular, occurring as encysted hæmatoma, contents hemorrhagic or serous. (This is by far the most common variety.)

(b) Usually small, superficial or deep-multiple, arising from inclusions of peritoneum. (Rare).

2. Inflammatory cysts.

(a) Tuberculous cysts. (Charles H. Peck).

(b) Snared off endothelium usually superficially buried in the spleen as the result of perisplenitis (small and multiple). Due to malaria, leishmaniasis, etc.

3. Degeneration cysts. (Solitary and large). Arising from secondary changes in infarcted areas from arterial degeneration or occlusion of blood-vessels by emboli with consequent necrosis of the pulp.

4. Dilatation cysts. Ectasis of splenic sinuses. (Polycystic disease Coenen-Fowler). These are multiple, fused and cysts usually riddle the organ.

5. Neoplastic types. (Lymphangioma, hæmangioma). It may not be possible to distinguish Group 4 which may be borderline in its tendencies from this group. The differential criterion is still obscure.

From January 1, 1922, a number of cases have been brought to light. The following case hitherto unmentioned was discovered during a visit to the Warren Museum, Harvard Medical College. The curator kindly supplied the following:

Specimen No. 8585. Cystic spleen. Male, age forty, died suddenly probably from apoplexy. The organ was considerably enlarged and the substance partly replaced by numerous thin-walled cysts. Contents coagulated on hardening. Cavities communicated by small openings and are probably in relation to the lymphatic system. This was an autopsy specimen, and may be included under the caption polycystic disease.

Egon Ewald describes two cases. One was a serous cysts, the size of a child's head, situated at the lower pole. Pre-operative diagnosis, ovarian cyst. The second was also a large, solitary blood-cyst which was surrounded by scanty remains of splenic tissue. Splenectomy was performed in both with recovery.

Lombard and Duboucher report a case of encysted hæmatoma without a distinct wall. The development of the clinical tumor was coincident with a severe attack of malaria, but the cyst was considered to be an old process. The contents were pure blood in various stages of disintegration. Because of dense adhesions subcapsular splenectomy

was successfully performed without bleeding after ligation of the pedicle. These authors in addition to 41 cases of this kind assembled by the writer, have collected 17 others.

Harnett has also reported a traumatic encysted hematoma. Three years intervened between the injury and the occurrence of malaria which caused swelling, pain and fever sufficient to warrant splenectomy. Convalescence was uneventful. It is recalled that Harnett reported a similar case in 1907 (previously incorporated in my series) of a large cyst full of altered blood due to spontaneous rupture of a syphilitic intrasplenic aneurism. Wassermann reaction was negative in his recent case.

Costanini also reports a cyst with bloody contents in a malarial spleen adherent to the diaphragm. The outer wall was formed by the splenic capsule and he believes the adhesion caused the splenic pulp to separate and to result in hemorrhage. Successful splenectomy after preliminary pedicle ligation. This was followed, however, by a violent outburst of malaria.

Charles H. Peck reported a case of tuberculous cyst before the Southern Surgical Association, December 11, 1923. Details of this case are not available at this writing.

More recently Gosselin has reported a case of degeneration cyst, which all but involved the entire spleen and contained altered blood. There was a history of malaria twenty-eight years previously. Splenectomy was successfully performed by Samson. There was no injury. Factors considered in the mode of origin were pregnancy and possible embolism twenty-four years previously or selective vascular degeneration evidenced by high blood pressure with consequent spontaneous rupture of an intrasplenic blood-vessel. (No evidence of lues). Almost complete obliteration of a large branch of the splenic artery was present which suggested that a kinking had occurred, possibly induced by pressure of an enlarged spleen. A developmental anomaly of this branch was suggested as a contributing cause simulating the tortuous course of the main vessel.

In all, 36 cases of non-paracystic cysts have been treated by splenectomy, the result is unstated in two cases. In 34 cases one death occurred. Mortality of about 2 per cent.

Echinococcus Cysts.—The elongated shape of the spleen has been said to be characteristic of the disease. Michaelson believes this results because of the predilection for the centre of the organ, causing the poles to be separated by growth of the cysts. Hitzrot's specimen assumed this shape. Emphasis is laid upon the development of toxic symptoms from dissemination of echinococcus fluid. These are said to be due to anaphylaxis. Fuster and Godlewski observed such symptoms five days after drainage. Tapping is dangerous and should not be used even as preliminary to splenectomy unless due protection is afforded the peritoneal cavity. Transplants may occur in the abdominal wall, but in spite of this warning, this feature is brushed aside by Cignozzi who advocates splenostomy as the treatment of choice for the reason that in his experience adhesions have generally interfered with the performance of splenectomy. A persistent fistula has resulted in some from marsupialization (Solieri, Heurtaux) others have been successful. (Huntington). Cignozzi found hydatid cysts in the spleen in 4 of his 62 cases of echinococcus disease, while the liver was involved in 44. The cysts in the spleen had a capacity of from 200 to 600 c.c. and the outline of the spleen was characteristic. The general health was good, but albumin and casts were found in the urine. The latter disappeared in from four to six days after operation. Cignozzi stresses the necessity for later plastic repair of the

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breach in the abdominal wall. He considers the secret of success lies in making a very wide opening in the cyst and maintaining an ample external opening from the outset. He believes it to be of the utmost importance to make the incision in the cyst wall as extensive as possible, to the end that there may be a correspondence between the dimensions of the cyst and of the splenostomy opening. The cystic cavity is completely filled with sterile gauze which is changed after 48 hours and then daily for 8 to 10 days. No irrigation of the cavity is practiced. Packing must be continued conscientiously for 3 to 5 months.

Lubbers and Nordenbos report a fatal case following splenectomy and discuss cases reported especially in the Dutch literature. These authors are of the opinion that the so-called "descending types" lend themselves more favorably to splenectomy than the ascending ones.

Martelli has reported three cases of echinococcus cysts and believes diagnostic signs are to be found in the blood and in the urine. Eosinophilia reached four times the normal. Two of the cases exhibited albuminuria which disappeared after operation. Martelli also recommends Marsupialization "a capitonnage."

H. W. Mills has recently reported four cases of hydatid cysts of the spleen. This author states that but twelve other cases have previously been reported in the literature of North America. (Nine cases reported by Lyon up to July 1, 1901, and three cases subsequently by Cahana, Jones and Edleman). This author reports a total of fifty-six cases subjected to splenectomy with a mortality of 14.3 per cent.

CO-EXISTENT NEPHROLITHIASIS AND URETEROLITHIASIS ON OPPOSITE SIDES

By W. FRANK FOWLER, M.D.
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THE simultaneous lodgement of a stone in one kidney and another in the opposite ureter is sufficiently unusual to merit discussion, particularly concerning treatment.

The subject was strikingly brought to my attention by the case of a boy nineteen years old. This patient was seen first at his home after a severe attack of pain in the lower right side and back had driven him from his work to his bed. He was pale and thin. The abdomen was somewhat retracted and slightly rigid in the lower right quadrant. There was some tenderness on deep pressure in the appendix region. The temperature was normal. During the previous evening and night spasmodic pain had occurred at intervals in the right side and back. The patient vomited several times and had eaten nothing since the beginning of the attack. After removal to the hospital the leucocyte count was 15,600 and the polymorphonuclears 83 per cent. The temperature had risen to $101\frac{3}{8}$ ° r. The urine was loaded with pus and the röntgenogram revealed two dense shadows, one deep in the pelvis in the region of the right ureter near the bladder, the other apparently in the lower pole of the left kidney (Fig. 1). Preliminary cystoscopy by Doctor Waterman showed œdema and swelling of the right ureteral orifice. The catheter would not enter. The indigo-carmin solution was not excreted from the right side. There was total excretion from the left side in eight minutes.

The significance of the early history became manifest, as frequently happens, after the diagnosis had been established by the urinalysis, röntgenograms and cystoscopy. During early infancy, for example, the child often danced and screamed before voiding. The X-ray examination a few years later, however, was negative. No cause for the pain was discovered, but the attacks became less frequent. During the past few years dull pain, usually of short duration, recurred at intervals of several weeks or months, sometimes with vomiting. There was no nocturnal voiding. The attacks were not incapacitating.

At operation on September 23, 1923, a smooth oval calculus which was impacted in the lower right ureter was removed through the extraperitoneal incision of Gibson. The temperature, which rapidly rose on the day of admission to $103\frac{1}{8}$ ° r., became $104\frac{1}{8}$ ° r. on the following day soon after the operation and gradually declined to normal at the end of a week. A smear on the tenth post-operative day from the left ureteral urine showed many pus cells and Gram-negative bacilli but the urine from the right (operated) side contained merely moderate numbers of pus and red cells and no organisms. The cultures, however, from both sides developed Gram-negative coliform bacilli. Cystoscopy on the tenth post-operative day revealed considerable swelling and œdema about the meatus of the right ureter, but the catheter could be passed to the kidney pelvis. The urine from the left side was very cloudy, that from the right bloody, probably due to trauma. The phthalein excretion from the right side was 10 per cent. 20 minutes after intravenous injection. The left side excreted 30 per cent. 20 minutes after the injection. Operation on the left side not advisable because of the low excretion. Cystoscopy on readmission January 4, 1924, showed much floeculent pus in the bladder. The left meatus was somewhat inflamed and considerable purulent urine flowed from it. The right side appeared normal. The indigo-carmin was excreted in good quantity from both sides, probably a little more from the right. There was marked improvement in function since the previous examination.

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At operation on January 5, 1924, a branched calculus in the lower pole of the left kidney was readily palpated through the overlying, thinned parenchyma. Apparently the thinning was due to pressure atrophy without necrosis. This stone was removed from the lower calyx in which it was firmly impacted through an incision in the pelvis. Another stone the size and shape of a cucumber seed was located and removed digitally from the middle calyx in which it was lying free. The pelvis and calyces were moderately dilated, but there were no gross evidences of renal infection. The smaller stone which was not revealed by the X-ray examination prior to the first operation may possibly have formed in the interim. A febrile reaction similar to, but less severe than that which followed the ureterolithotomy, ensued.

Regarding frequency Braasch observes that among 450 patients who were operated on for nephrolithiasis the bilateral occurrence of stone was noted in 48 instances, and in only 3 cases was the stone found in the kidney on one side and in the ureter on the other. The shapes assumed by calculi, according to Keyser and Braasch, apparently depend chiefly upon the site of the development of the stone. For example, small calculi lying in the minor calices usually have the contour of the calyx and larger "stag horn" stones may

follow the pelvic outline. The "Jack stone and mulberry" forms, however, are not readily explained on such a basis.

The branched stone in my case appeared upon X-ray examination to be without doubt a single calculus, but Braasch reminds us that the merged shadows of partially superimposed concretions often simulate a single branched stone. Barney, also, observes that one large X-ray shadow may obscure other smaller shadows lying in front of or behind it and lead to the removal of but one stone without further search. And Braasch states that multiple stones are often removed from the kidney at operation after the röntgenogram had exhibited only one shadow. Furthermore, Mayo warns us that shadows apparently due to calculi in the right kidney may be cast



FIG. 1.—Röntgenogram showing one calculus in the lower right ureter and another in the lower pole of the left kidney.

by stones in the gall-bladder, although gall-stone shadows usually may be identified by their concentric layers and density. In spite of the reliability of the X-ray, Braasch writes that "interpretation of the röntgenogram without complete clinical and cystoscopic data is inaccurate and operation based upon such evidence alone is not good surgery."

Many expedients have been employed to the end that stones might not be overlooked at operation. Barney, for example, suggests flushing the kidney pelvis in order to dislodge and wash out small calculi. Barney also advocates the old-fashioned method of needling the kidney, preferably with the rounded end of a small flexible probe. Mayo, on the other hand, favors digital examination of the kidney pelvis and deprecates the practice of needling. More recently the use of the fluoroscope at operation has reduced to a minimum the likelihood of overlooking calculi. Barney has adopted an X-ray check-up for overlooked stone before the patient leaves the hospital with a view to performing a second operation if necessary ten days to two weeks after the first, unless contra-indications exist.

My patient exhibited, during a period of several years, attacks of pain which were not severe enough to call attention to his urinary tract. Fortunately, however, the impacted stone in the left kidney remained relatively small and the organ suffered little damage. Braasch reports that in a series of 484 operations for nephrolithiasis, 204 nephrectomies were done. In most instances removal of the kidney was necessitated by pyonephrosis and stone. In many of these cases symptoms had existed for many years and the condition was either unrecognized or had remained dormant. Braasch observes, also, that the large proportion of multiple stones (188) may be due partly to the fact that most of the patients of this group had experienced symptoms for a long time. It is evident that the formation of the stones and the destruction of the kidney could be largely prevented by early operation. Possibly the symptoms mentioned by Braasch bulked larger in retrospect than they did during the slow process of stone formation and accretion and of kidney infection and destruction. However, Ochsner and Sanes emphasize the importance of careful history taking. Beyond question many of us rely too much upon laboratory findings and too little upon personal observation.

Regarding the differential diagnosis, the errors made when the stone is on the right side are perfectly familiar. However, the statement of Braasch is illuminating that 21 patients with stone in the left kidney had had previous operations on the appendix or gall-bladder.

Although the etiology of nephrolithiasis is obscure, there seems little doubt that infection plays an important rôle. We are reminded by Braasch, however, that even with a large branching stone the urine may contain merely a few microscopic pus-cells or red blood-cells. Even though observers agree that these findings are not diagnostic, nevertheless, according to Braasch and Moore, their presence demands an X-ray investigation of the entire urinary tract. My patient showed much pus in the urine from the left kidney where the stone resided. Therefore, the stone was removed although the renal

function was good. Braasch makes the interesting observation that with single stones the pyonephrosis usually is secondary to the stone formation, but multiple stones are often formed secondarily to the inflammatory process.

It is generally conceded that the continued presence of a stone in the kidney perpetuates the infection and the absence of pus from the urine is a criterion of cure. However, Braasch reports that the urine of 8 of 69 patients found negative on X-ray examination after an interval showed red blood-cells and pus-cells usually scanty. This indicates that a mild degree of infection may persist for a long time after the removal of the stone and that possibly such infection is the original etiologic factor. The 13 cases in which recurrence was proved showed red blood-cells or pus-cells to a variable degree in every instance.

Concerning the surgical treatment of nephrolithiasis pelviolithotomy is the operation of choice by unanimous consent. Barney advocates pyelotomy even though the difficulty of removing stones from the kidney through the pelvis may tax the surgeon's utmost skill and ingenuity. And Eisendrath describes a technic of enlarged pyelotomy for renal calculi which is designed to extend the scope of the usual procedure. Fortunately the applicability of pelviolithotomy is wide since this procedure was employed 206 times in a series of 484 operations for stone reported by Mayo.

Nephrolithotomy is an operation of necessity rather than of choice since damage to the kidney parenchyma and hemorrhage often result. The latter is sometimes severe enough to necessitate nephrectomy. The experimental nephrotomies of Magoun in dogs emphasize the possibility of resultant hemorrhage and infection. Mayo indicates the field for nephrolithotomy in the statement that it was done for example in secondary operations when the kidney was firmly fixed as a result of former operation. Braasch reminds us also that sometimes when the stone is situated in the pelvis or calyces either nephrotomy alone or combined with pelviotomy is preferable to simple pelviotomy if drainage is required for areas of necrosis in the cortex. However the procedure was utilized only forty times in a series of 484 operations for stone. I believe that the frequent necessity for nephrectomy in pyonephrosis and stone (204 nephrectomies in a series of 484 operations reported by Mayo) is due to the insidious onset and progress of these associated conditions rather than to careless observation. Observers agree that the very small symptomless calculi had best be left alone and a policy of watchful waiting adopted. Many of these little stones will pass spontaneously. Braasch also reminds us that some of the patients with bilateral nephrolithiasis are better off without operation because of the absence of subjective symptoms or the large size of the stones. A smaller number was considered inoperable because of the advanced destruction of the kidney or secondary infection. The symptoms apparently were not sufficiently severe to require operation.

The mild attacks of pain which my patient endured for several years finally culminated in an attack which could not be ignored. Even then, however, neither the severity nor the radiation of the pain suggested

renal colic. Apparently, the stone which was anchored in the left kidney remained symptomless.

In view of the right-sided obstruction ureterolithotomy was done as an emergency operation. The effect upon the kidney of ureteral blocking deserves consideration. Barney states that sudden, complete occlusion of one ureter, either experimental or clinical, may produce no symptoms and that uninterrupted recovery will follow in 21 per cent. of the cases. Infection of the kidney due to, or aggravated by occlusion, requires subsequent nephrectomy in 15 per cent. of the cases. One ureter may be completely blocked for ten days without destroying the integrity of the kidney. Of fifteen cases in which the subsequent condition of the kidney was investigated, moderate hydronephrosis was found in 80 per cent.

Caulk and Fischer demonstrated the effect upon the kidney of complete ureteral obstruction by ureteral ligations in dogs. Invariably the kidney soon became hydronephrotic. Caulk and Fischer conclude that if the kidney is to be conserved the obstruction must be relieved within two weeks. Keyes, referring to bilateral calculi, stated that impaction of a stone in the ureter of the sounder kidney may temporarily reduce its function below that of its fellow. Under such conditions it is safer to operate first upon the side with the ureteral stone. Keyes observed, also, that simultaneous bilateral operation may be attempted if the patient's condition is relatively good and the first operation not unduly long.

Since my patient had suffered a complete blocking of his right kidney for an indefinite period, it seemed best to merely relieve the obstruction at the first operation. The function of the right kidney after removal of the ureteral stone was found to be so low that we deemed it advisable to defer operation on the left kidney. We feared that the operative trauma might seriously diminish the function of the overworked left kidney, particularly since the urine from that side contained much pus.

The type of anuria described by Frank which is due to unilateral obstruction by a calculus in the ureter is pertinent to this discussion. Frank believes that anuria may be due to sudden, intense congestion of the unobstructed normal kidney resulting from inability of the efferent vessels to carry off the blood and the consequent stoppage of the urinary excretion.

Frank contends that unilateral calculous anuria is not infrequent as he has seen five cases and has collected 188 reports of the condition from the literature. Although tolerance for anuria of the obstructive type is surprising, Frank nevertheless warns us that relief should be afforded promptly, preferably by pyelotomy on the obstructed side. This procedure results in a resumption of function by both kidneys. The increased liability to cessation of function if the unobstructed kidney harbors one or more calculi is obvious.

The improved function which the right kidney of my patient exhibited three months after the ureterolithotomy justified the delay in operating on the left kidney. The febrile reactions which followed both operations were characterized by high leucocyte counts and the absence of subjective symptoms.

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Lowsley observes that the inevitable urinary leakage following ureterolithotomy invites the laying down of fibrous tissue about the ureter with consequent liability to stricture formation. Therefore, the follow-up examination should include catheterization of the ureter up beyond the point of operation.

Regarding the frequency of recurrence of renal calculi, Braasch concludes that the percentage should be less than ten. Other observers, however, are less optimistic. Cabot, for example, claims that reëxamination of 66 patients previously operated on for renal calculus at the Massachusetts General Hospital showed a recurrence of stone in 49 per cent. Barney states that there is an unfortunate lack of investigation regarding recurrent or overlooked renal calculi. The few available data show that stones are subsequently found in the kidney after operation in a surprising number of instances, but it is impossible to state which of these stones are "recurrences" and which are "left overs." Actual recurrence is unquestionably very frequent. Robins, also, believes that a more careful reëxamination of patients after an interval would reveal frequent recurrences.

Braasch observes, however, that in seventy-five cases the findings on reëxamination were negative, although many of the patients had aches and pains suggestive of recurrence. And in five instances suspicious X-ray shadows appeared which were definitely proved to be extra-renal or extra-ureteral. Also, the urine of several patients found negative on X-ray examination after an interval showed red blood-cells and pus-cells usually scanty at the same time. It is evident that the data suggestive of recurrence must be carefully evaluated.

Regarding the prophylaxis of recurrence, Ochsner strongly advocates the drinking of distilled water. Nevertheless, Lowsley reported the removal of a calculus from the right kidney, later the removal of a calculus from the left kidney and recently the patient has returned with a recurrence in the right kidney in spite of the drinking of distilled water. The statement of Braasch is encouraging, that repeated recurrences in the same kidney requiring a third operation are rare.

Summary.—A young man suffered attacks of dull pain in the right side and back during several years. Finally a more severe attack occurred, but the vague subjective and objective symptoms and signs did not suggest calculus. The diagnosis was made by urinalysis, röntgenograms and cystoscopy.

Since nephrectomy is necessary in about half of the cases of nephrolithiasis, either the clinical picture is obscure or else the histories are not well taken. In a series of 484 operations for renal calculi the coexistence of one stone in the kidney and another in the opposite ureter was noted only three times.

A stone which blocks the ureter causes infection and loss of function in the kidney above it. The obstruction must be removed within ten days if the integrity of the kidney is to be preserved. Considering the fact that the function of the obstructed kidney is unknown, it seems wise to defer operation

on the other stone-bearing kidney. The operative trauma under such circumstances might dangerously lower the gross excretion.

Digital exploration of the kidney pelvis and fluoroscopy with the kidney delivered from the incision have minimized the likelihood of overlooking renal calculi. The estimates regarding the frequency of recurrence vary from 10 to 49 per cent. Perhaps the higher estimates are based partly upon overlooked stones. The data suggestive of recurrence are deceptive and must be carefully interpreted.

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KNEE-JOINT INJURIES AND THEIR MANAGEMENT

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THE injuries of the soft tissues involved in the knee-joint (Fig. 1) may be enumerated as follows:

1. Lacerations of the synovial membrane.
2. Lacerations of the anterior and posterior crucial ligaments.
3. Rupture and traumatism to the fibrous capsule.
4. Tears of the ligamentous structures outside of the knee-joint proper.
5. Injuries to the tendons surrounding the knee-joint.
6. Trauma to the bursæ about the joint.

The injuries to the synovial membrane (Fig. 2) are in themselves not very extensive unless the knee-joint has been punctured by a foreign body or ruptured by a fracture into the joint. In the absence of infection, the membrane heals readily without very much contraction or scar-tissue formation and consequently very little limitation of motion in the joint.

Hemorrhagic effusions into the joint are not uncommon from direct trauma. One such case—a young woman who while on the golf course was struck directly upon the patella by a swiftly flying golf ball—was carried from the field and brought directly to the hospital. The joint was already filled with fluid and the aspiration of the joint, which was done immediately to relieve the great distention, showed a large quantity of liquid blood. This aspiration was repeated three times before the hemorrhage ceased. Ice-caps were applied, together with Buck's extension, carrying sufficient weight to separate the articulating surfaces and the patient made a complete recovery. The danger in these cases is obviously the traumatic synovitis and the subsequent adhesions which are so apt to occur.

The bursæ about the knee-joint are subject to frequent trauma and infection. Of the twelve which lie about this joint, the three situated in the front are probably most frequently involved. Of these the superficial one or the prepatellar bursa is most often the site of injury. Its involvement is best exemplified in the "housemaid's knee." Because of its location in front of the patella and patellar tendon, it is so easily bruised and punctured and so often becomes infected that it forms a part of the very common minor conditions seen in general practice. Occasionally the bursa about the outer head of the gastrocnemius may become enlarged and require surgical interference. The bursa beneath the tendon of the popliteus lying between the tendon of that muscle and the femoral condyle is almost always an extension from the synovial capsule and frequently swells during an acute synovitis with effusion. This swelling, of course, disappears simultaneously with the decrease of the synovial fluid. The diagnosis lies between swellings and glandular enlarge-

ments in the popliteal space, aneurism of the popliteal vessels and popliteal lipomata, all of which frequently may resemble the enlargement of this bursa.

The pathologic changes which occur depend entirely upon the type, extent and duration of the trauma. A simple direct injury produces serous effusion or hemorrhage and occasionally a rupture of the bursal sac. These simple effusions usually need no other treatment than firm bandaging or counter-

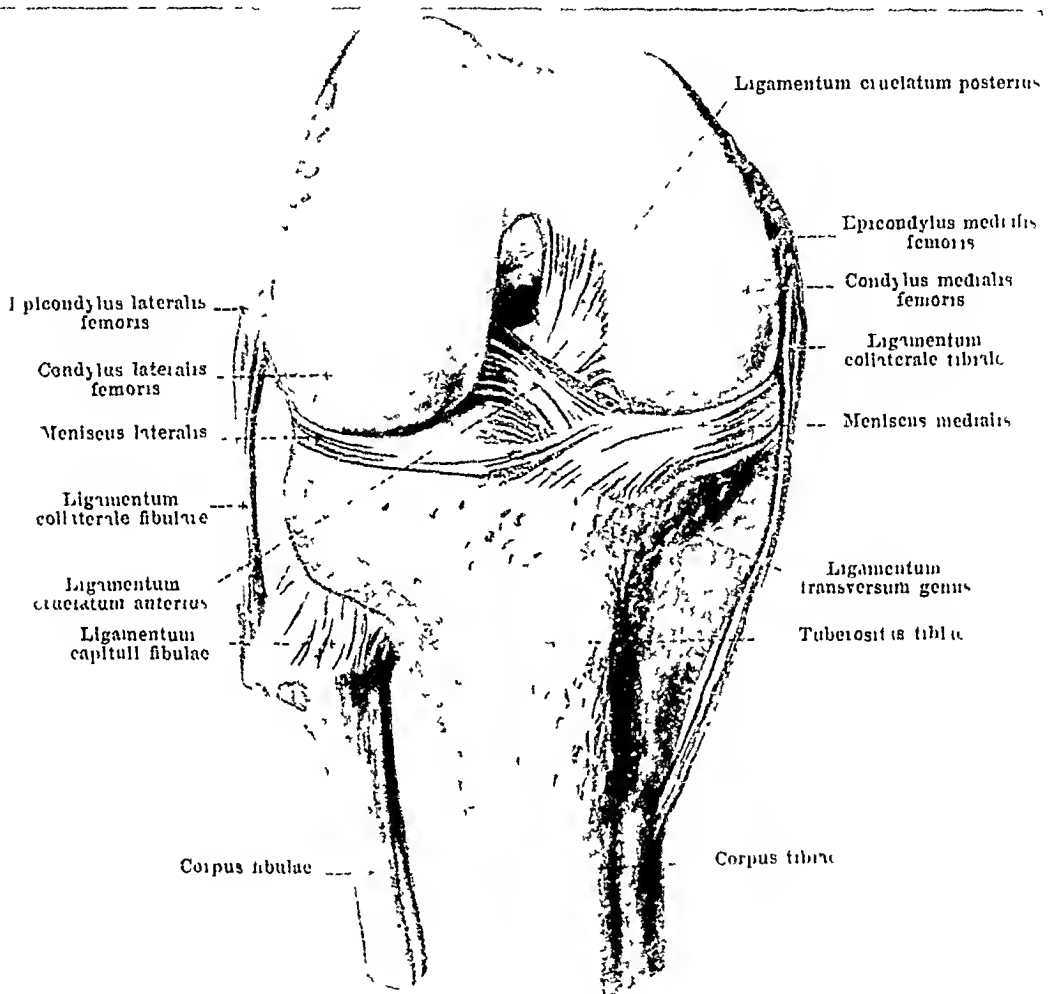


FIG 1.—Normal knee-joint (Spalteholz)

irritation by heat or some other irritant. This, together with immobilization by strapping and rest of the part, is the method used by most surgeons. If this simple procedure does not suffice, aspiration of the sac is undertaken. In the more stubborn cases aspiration of the fluid, followed by the injection of the tincture of iodine, a 20 per cent. carbolic acid solution, phenol camphor or formalin in glycerin may be utilized to a good advantage. In the chronic traumatic involvements, especially those in which suppuration has taken place, there is only one rational procedure, *viz.*: complete excision of the entire bursa. Simple curettement or scarification of the inner lining does not, then, give satisfactory results.

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The *crucial ligaments* are so well protected that they are rarely injured excepting by penetrations through the popliteal space or rupture resulting from dislocation or by fractures into the joint. Occasionally one sees a partial rupture or loosening of one of the crucial attachments in the extreme hyper-

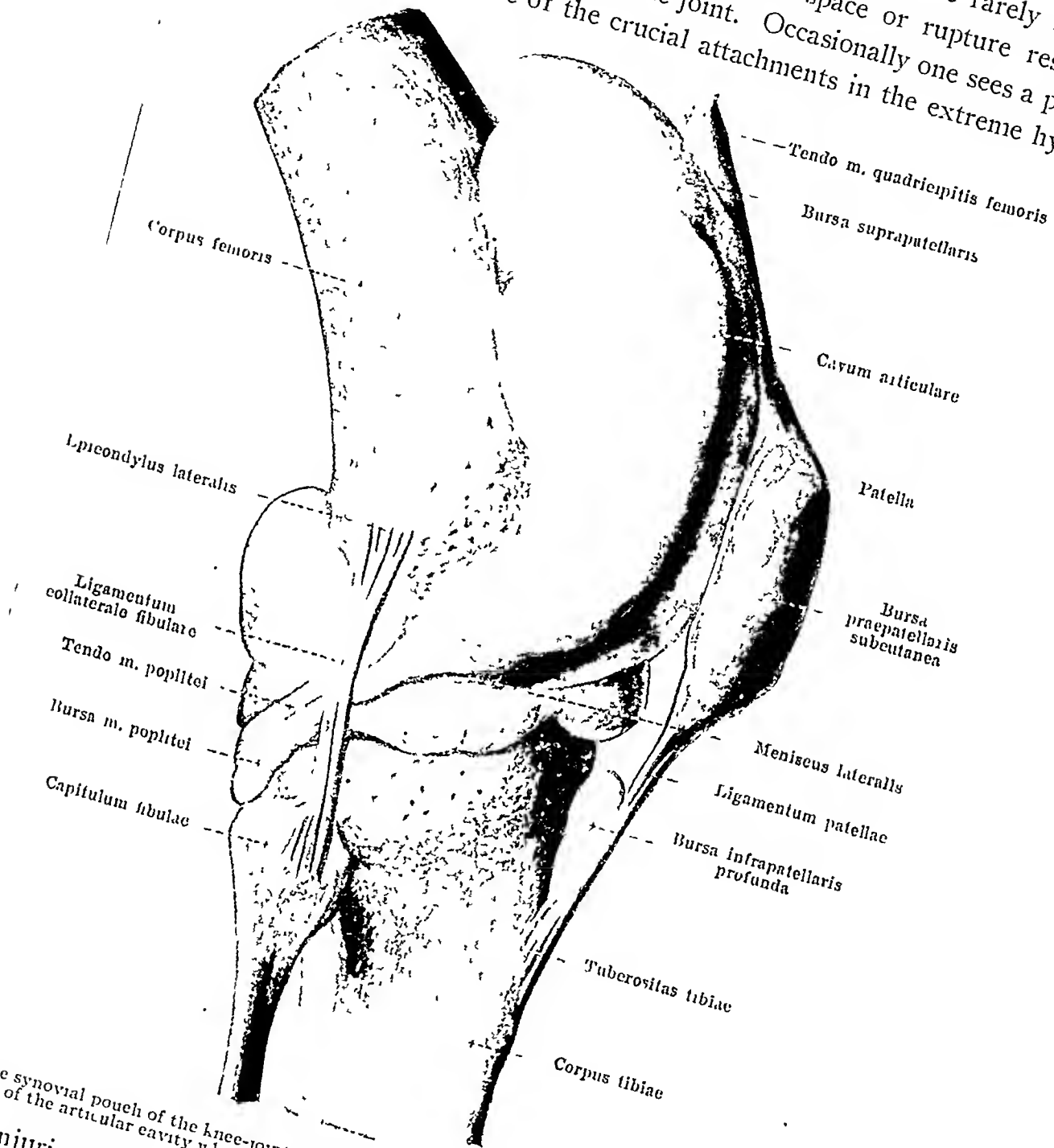


FIG. 2.—The synovial pouch of the knee-joint greatly distended represents the size and general form of the articular cavity when filled with fluid or other material. (Spalteholz.)

extension injuries. There are a number of cases on record in which the spine of the tibia was fractured from the excessive strain on the crucial ligaments. Vulliet¹ reports two cases which were diagnosed by means of the radiograph in which osseous lamellæ were torn away, one in the region of the attachment of the posterior crucial ligament and the other in the anterior portion of the

spine of the tibia at the point of insertion of the anterior ligament. In one case which has come under my observation, a portion of the spine was loosened entirely and acted as a foreign body, and when it dropped far back between the condyles of the femur and the tibia it prevented flexion beyond 35 degrees. In the ordinary crucial ligament lacerations, rest and immobilization is all that

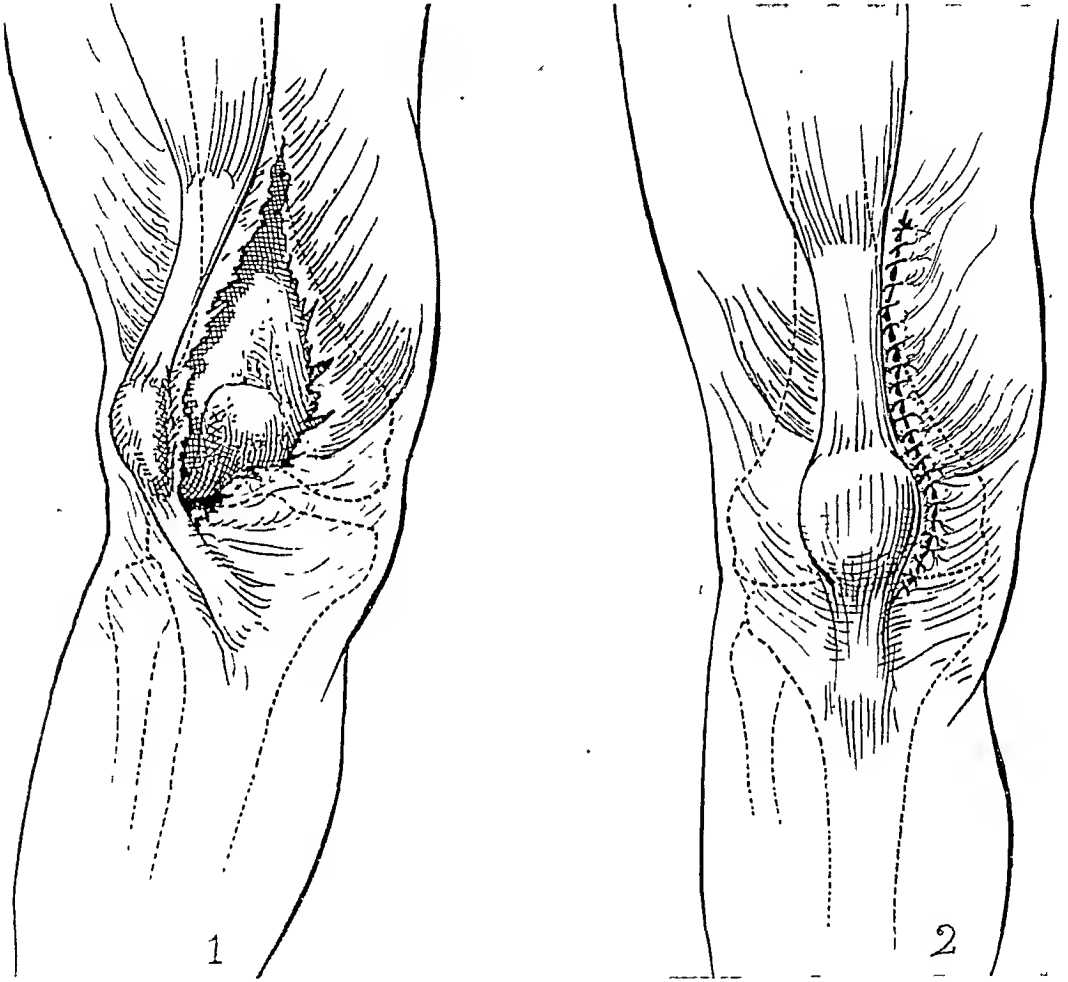


FIG. 3.—1. Dislocated patella and rupture of the fibrous and synovial capsules (antero-posterior view).
2. Restoration of tissues to their normal anatomic positions.

is necessary. Where there is a fracture of a portion of the bone with misplacement of this fragment, open operation is usually indicated.

The fibrous capsule is frequently injured by external violence or penetration and often tears from certain of its attachments, permitting of dislocation of the tibia on the femur or lateral displacements of the patella either external or internal, depending upon which portion of the capsule is torn.

When one considers that the fibrous capsule of the knee-joint in a fresh adult cadaver will stand an internal pressure of about fifty pounds per square inch, one can readily see what great force is necessary to rupture it. The experiments to determine the above fact were made by driving a trocar through the centre of the patella and attaching this trocar to a hydraulic pressure

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pump so graduated that the resistance could be accurately measured. The extent of injury which may occur can best be represented by citing a case which has come into the writer's practice during the past year.

A woman of forty, weighing about 215 pounds, was knocked down by an automobile and struck on the outer side of the right knee-joint. The injury was sustained about a year prior to the time that the patient came for treatment. She walked with the aid of a crutch with the right leg distinctly flexed in a knock-knee position and was unable to extend or further flex the extremity. The patella lay in a fixed position on the outer aspect of the articulation and could not be moved from that position. Careful pre-operative analysis showed that the quadriceps extensor and patellar tendons were not ruptured. There was no dislocation of the femur on the tibia. The fibrous capsule on the inner side of the knee-joint had been ruptured longitudinally to such an extent as to permit of the external displacement of the patella described above. The internal lateral ligaments had been sufficiently torn to permit of the knock-knee deformity (Fig. 3—1).

In the repair of this injury it was necessary to restore these tissues to their normal positions. An extensive exposure of the anterior portion of the knee-joint was accomplished by an incision beginning about four inches above the upper aspect of the patella in the middle of the thigh and extending downward to within one inch of the patella, then curving sharply outward, thus avoiding the patella and following down along the side of it to a point an inch below the patella, then obliquely across the patella tendons ending internal to and slightly below the tubercle of the tibia. This incision penetrated the skin and subcutaneous tissue as far as necessary to expose the structures to be dissected from the underlying tissues as far as possible attached to the skin. Through such an exposure repaired, leaving as much fat as possible freed sufficiently from its abnormally fixed position and the patella with its tendons was brought back into its usual place. The rent in the capsule on the inner side was repaired, as shown in Fig. 3—2.

In some cases the injury to the capsule is not sufficiently severe to tear it, but stretches it to such an extent that a recurrent dislocation of the patella takes place either internally or externally as the case may be. The displacement externally is the more common one, as the ridge formed on the interior aspect is much larger than that on the outer. These dislocations recur from time to time when the patient suddenly twists the leg on the thigh with the knee in a partially flexed position.

The repair of this condition calls for an imbrication operation upon the capsule where it has been stretched or loosened, very much as is done in the hernia operation. The mere folding and suturing of the capsule is not sufficient. In another method of operation which has been described in the literature, the tubercle of the tibia with the patellar tendon attached is chiselled away from the tibia and displaced internally or externally as the case may demand. There may be cases in which the use of both operations is indicated. However, it is my belief that the imbrication upon the fibrous capsule is the logical and only necessary procedure in most instances.

Chauvin and Liautard² collected 138 cases of recurrent dislocation of the patella in which the majority occurred about the twentieth year and in which 43 per cent. were bilateral. They found the left knee affected more often than the right. Ninety-four per cent. of these cases had dislocations outward.

Meyer³ utilizes the suture of the long head of the biceps to the patella for internal luxation. For external luxation he recommends Gocht's method of transplanting the semitendinosus muscle to the patella and catching up and suturing the tendinous part of the vastus medialis.

The ruptures of the external ligaments of which there are one internal lateral and two external lateral, may require repair by simple suture in the

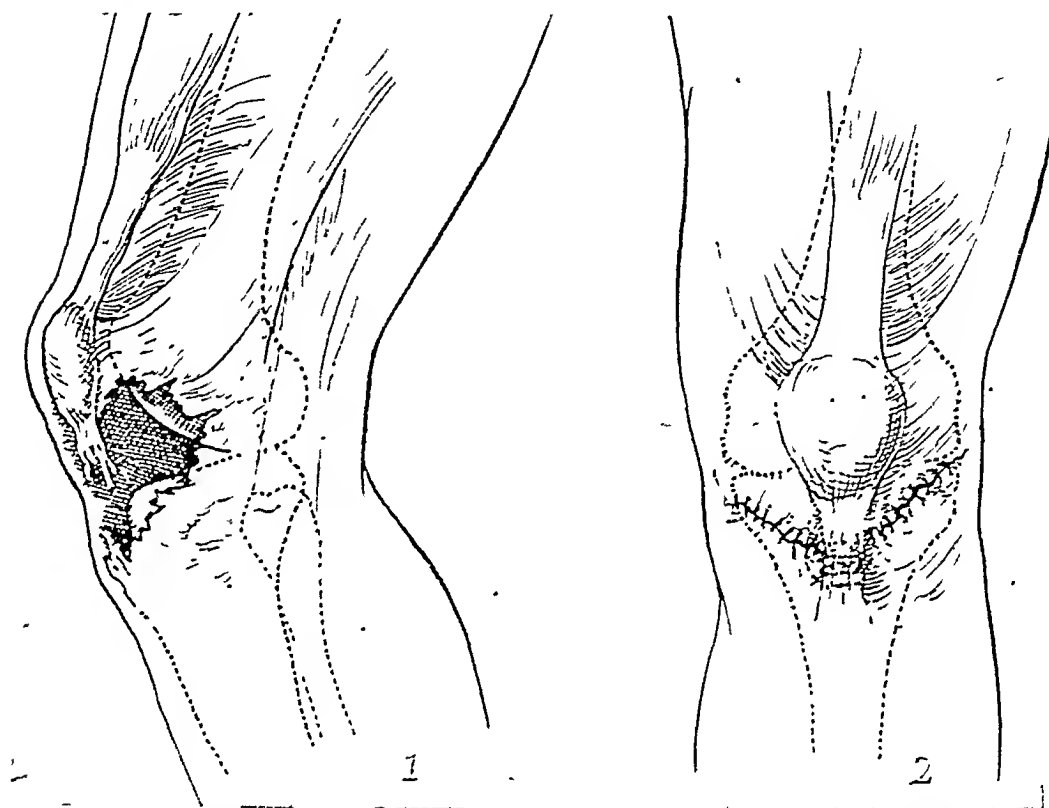


FIG. 4.—1. Extensive laceration of patella tendon and anterior portion of knee capsule. 2. Restoration of lacerated tissues.

early cases or substitution of fibrous tissue from the fascia lata in the old cases.

Of the tendons of the knee-joint, namely, the tendon of the patella and the tendon of the quadriceps extensor muscles, the first named is the one most frequently torn. The two following cases of the patellar tendon and one of the quadriceps tendon, will serve to demonstrate the types of rupture which are apt to occur, their mechanism and repair.

The first case is that of a young man, twenty-eight years of age, who, while exercising in a gymnasium slipped suddenly, throwing the entire weight of the body upon the right knee, which struck upon the sharp ends of a metal bar. The pain thus occasioned was excruciating, the patient fell over, and was carried from the gymnasium floor. The leg was straightened out and very soon the knee-joint began to swell greatly. He was able to flex his leg, but entirely unable to make any effort at extension. He was brought to Mercy Hospital within six hours after the accident, where X-ray examination revealed no injuries of any of the bony parts about the knee. Further physical examination showed that the knee-joint was entirely filled with fluid. The skin was not

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broken. On aspiration this fluid proved to be liquid blood. After this fluid had been withdrawn from the knee-joint the diagnosis could easily be made. With the examining finger upon the skin just below the patella, one could introduce the finger deep into the joint cavity and outline the semilunar cartilages, which fortunately had not been displaced or fractured.

Following the teaching of Murphy that it is unwise and unsafe to perform an open operation upon a joint immediately after accident, I waited for one week until nature had time to throw cofferdaming about the injured parts and until there was no longer any active bleeding into the knee-joint. In this way one can very frequently avoid infections where otherwise a fresh blood-clot and open lacerated tissues would make splendid culture-media. At the end of one week I made a semilunar incision, carrying it an inch lower than the line of rupture in the capsule. Obviously this was done so that our line of suture in the capsule and the skin incision should not lie in the same plane. Upon dissecting the skin back I found on examination nothing intervening between the skin and the joint cavity. After considerable difficulty I found numerous shreds of tissue both long and short, some of them attached to the patella and some just attached to the tubercle of the tibia. This was the remnant of the patellar tendon (Fig. 4). The fibrous capsule was torn jaggedly on either side of the patella tendon, extending inward about two inches and outward one and three-fourths inches. The repair of this proved difficult because I was obliged to gather together the shreds in an effort to make a presentable and sufficiently strong tendon to function in the case of a very large and muscular individual. After the capsule had been repaired and the shreds of tendon brought together, the knee-joint was closed without drainage and placed in a straight two-thirds posterior plaster splint with a Buck's extension of about ten pounds.

The wound healed by primary union, and after six weeks the patient was permitted to make an attempt at flexion. On the last examination, eight months after operation, the patient could fully extend the leg without the slightest difficulty.

A second case is one of a rather similar accident, but with the patella displaced downward instead of upward. A young man of about thirty-two years of age was struck by the bumper of an automobile. The injury was just at the insertion of the quadriceps extensor tendon into the patella. An X-ray showed no bone injury. A splint was applied and the patient permitted to go about for a period of two months. When the splint was removed the patient had no pain and no apparent deformity, but he was entirely unable to extend the leg. Examination at this time revealed, as in the first case, that there seemed nothing to intervene between the skin just above the patella and the femur. Upon closer examination the stump of the quadriceps extensor tendon could be located one and one-third inches above the upper end of the patella (Fig. 5-1).

The incision in this instance was a transverse one, so that we would have plenty of room to make a good repair or, rather to make a re-attachment of the tendon to the patella. After making an incision through the skin we found that we were immediately in the suprapatellar pouch of the knee-joint. The joint contained a very small quantity of a clear fluid and we were most careful not to introduce blood or even sponges into the joint cavity. The stump of the tendon having been exposed in order to bring it down to meet the patella, it was necessary to elongate the tendon at least one and a half inches. To accomplish this elongation two lateral incisions were made parallel and just at the side of the rectus femoris tendon (Fig. 5-2). These incisions extended upward a distance of about two and one-half inches on the inner side and about three inches on the outer side, dividing the attachment of the vastus lateralis and vastus medialis. In this way it was possible to bring the stump of the tendon down so that it could make a nice attachment to the patella, the stump was trimmed down for the attachment by easily be handled with sutures. The patella was then prepared for the attachment by making an incision through the periosteum and deflecting it backward—then three holes were drilled through the patella from before backward and the tendon was sutured to

it with several mattress sutures of kangaroo tendon through the openings thus made (Fig. 5—3). The reflected periosteum was next brought back and united to the tendon.

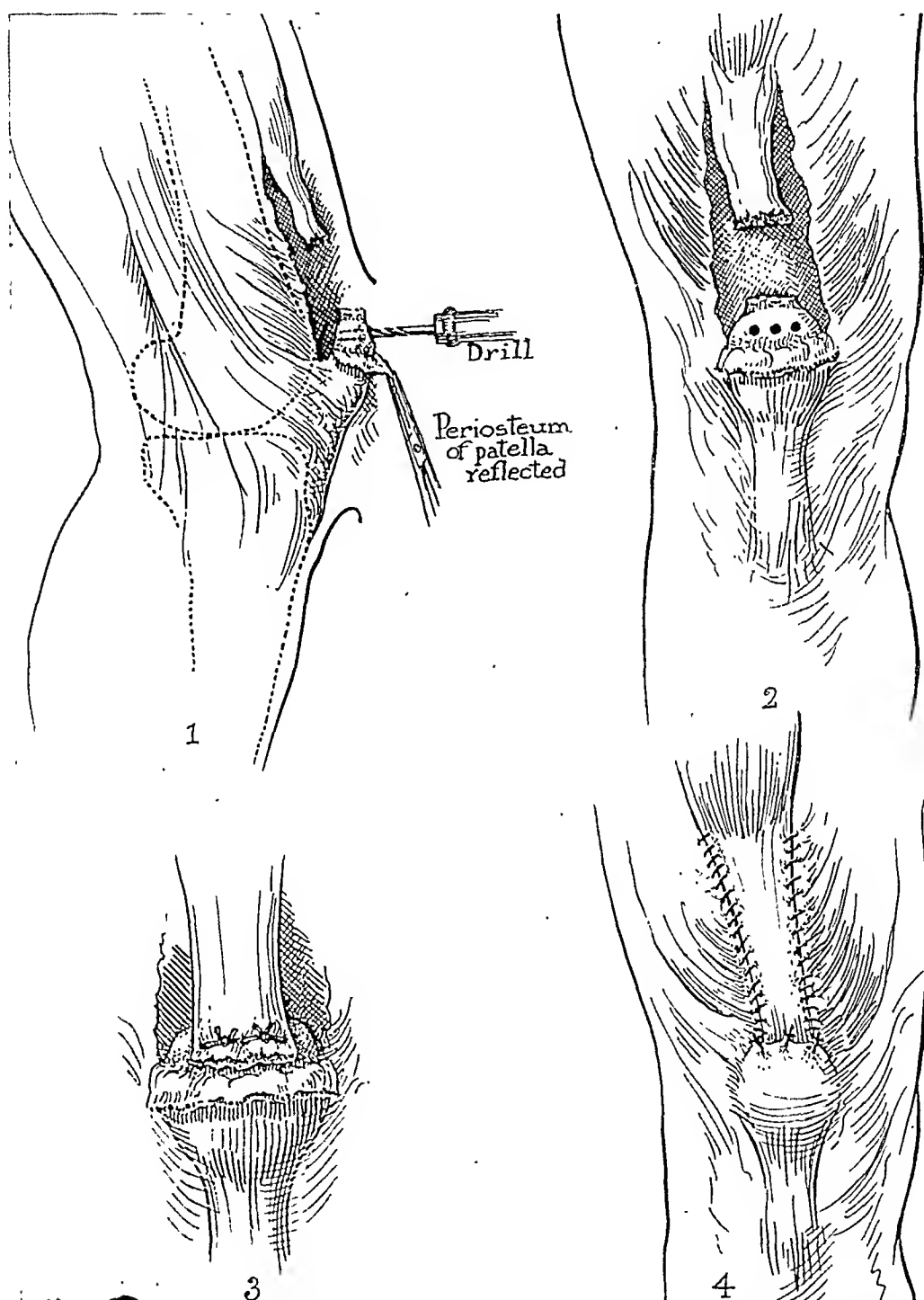


FIG. 5.—1. The stump of the quadriceps tendon has been freed and the patella prepared for the drill. 2. The final preparation for the suture. Note the lateral incisions to permit the quadriceps tendon to be brought down to the patella. 3. Mattress sutures in position, the reflected periosteum to be brought back to cover sutures. 4. Restoration of tissues.

This gave two definite attachments to the patella, one by means of sutures directly to the bone and the other by suturing the periosteum to the quadriceps. By this procedure we

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had no roughened surfaces to which the skin might become adherent and we had not in any way roughened the surfaces on the joint side of the patella (Fig. 5—4). The examination of the case one year after operation showed the knee-joint entirely stable and showed the power of complete extension with considerable strength.

In reviewing the literature on this subject we find very little which gives us an accurate comprehensive description of the processes of repair used by the various operators. There is no one technic which will apply in all cases, one must meet the emergency as it arises. Those tissues which have

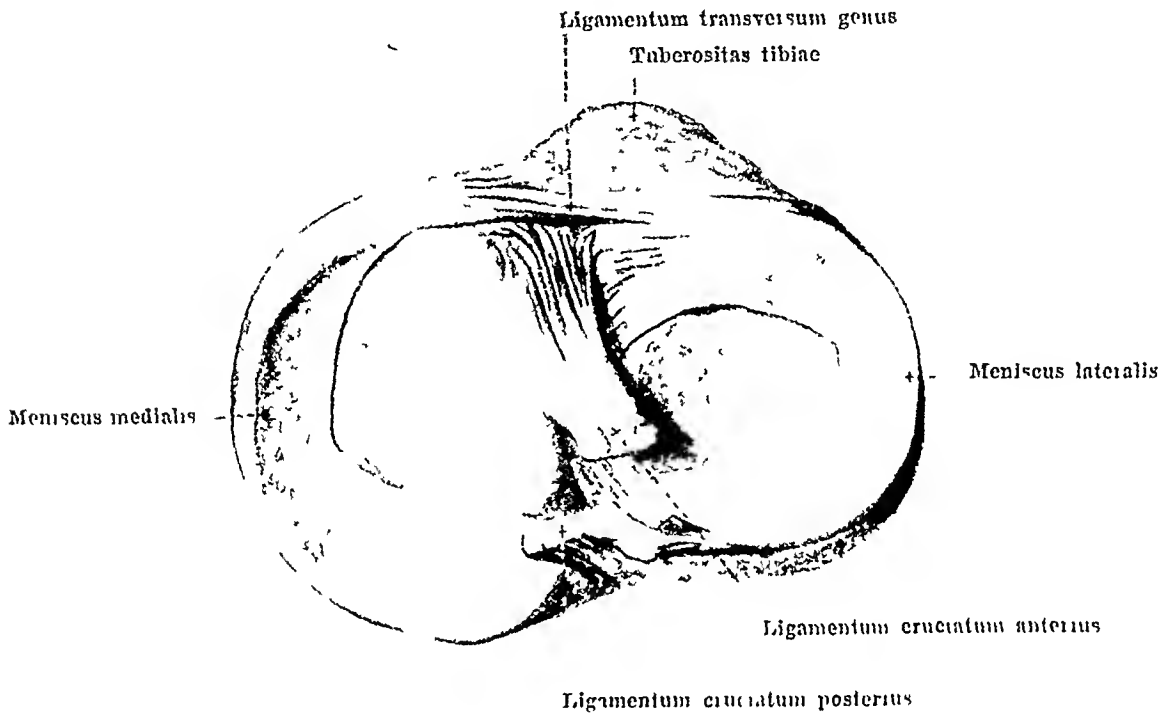


FIG. 6 —The semilunar cartilages and their attachments. (Spalteholz.)

been torn or detached must be reunited. Those tissues which have been so greatly destroyed as not to permit of reunion must be replaced by some similar material from other parts of the body. If there are not sufficient fibres left of the patellar tendon, a portion of the fascia lata may be used as a substitute. If the fibrous capsule is so greatly destroyed that it is impossible of repair, a portion of the same tissue may be transplanted into that part of the knee-joint.

Schwartz⁴ reports a case in which the diagnosis of a ruptured patellar tendon was made from the history and from the fact that the patella was abnormally movable. Upon operation it was found that there was only a slight tearing of some of the fibres giving a considerable bloody effusion on both sides of the tendons. The tendon was greatly elongated or stretched by the accident and was shortened by folding the patellar tendon on itself.

Semilunar cartilage disease, or internal derangement of the knee-joint, as it is called by the English surgeons, offers one of the greatest fields for surgical interference. These cartilages it will be remembered lie upon the surfaces of the tibial articulating cartilage (Fig. 6) and are in no way attached to it, excepting by the fibrous connective-tissue to the inner side of the knee

capsule along their external circumference. The posterior tip of the cartilage is attached to the posterior crucial ligaments and the anterior tip in the region of the anterior crucials. Lying in this position, thus attached, they are capable of very considerable mobility in various directions but when displaced or torn from these attachments they are subject to certain definite lesions. The mechanisms of these lesions is readily understood when we realize that a large majority of them occur in athletes and among the laboring classes, such as coal minors. Great violence is often brought to bear by the condyle of the femur being shoved upon or against the cartilage. The internal cartilage is naturally the one which is most often injured. The anterior half of this cartilage is much more often the site of injury than the posterior. Various authors give the proportion as 20 internal to 1 external. Rutherford Morrison of Newcastle places the proportion of internal semilunar cartilage injuries as 50 to 1 of the external. Walton in the *British Medical Journal* reports 85 cases, 81 of which were internal. Martin who has treated 449 cases among coal minors found that 92 per cent. were internal. He found that in 95.5 per cent. there were fractures and tears. In my own series the internal cartilage was injured 20 times to 1 external. The lesions may be classified as follows:

1. A simple tearing or detachment of the fibrous tissue holding it in place at its outer circumference, thus permitting it to be drawn into the joint and pinched between the femur and tibia when the knee is extended.
2. A loosening of the anterior tip or one-third of the cartilage which then becomes subject to crushing injuries.
3. Simple fractures of the cartilage in its anterior portion.
4. Multiple transverse or linear fractures.
5. Fraying or nipping of the cartilages with consequent fragmentation. (Fig. 7).

Some of the more unusual accidents are well illustrated in the following cases. In one case the patient sat upon his heel while adjusting an automobile tire and so greatly tore the internal cartilage as to permit it to lie obliquely across the tuberosity of the tibia. Obviously the knee could not be extended, nor could the cartilage be replaced to its normal position by any manipulations, even under anæsthesia.

In another case, that of an athlete, the transverse fracture was so complete that one of the fractured ends extended well into the joint and by repeated extension of his leg over a period of months, caused a deep hole to be gouged into the surface cartilage of the femoral condyle.

In a third case the fragmentation of the loosened cartilage was so complete that approximately fifty small pieces were taken out of the knee-joint at the time of operation.

Another unusual accident is that of a fracture and dislocation of the posterior portion of the internal semilunar cartilage. The patient, a football player, who was avoiding a tackle by a side-step, was struck on front of the knee, causing the leg to be hyperextended with the knee adducted. This mechanism forced the internal condyle of the femur against the posterior portion of the semilunar cartilage and dislocated it, tearing it loose from the circumferential attachment. The pain in this case was internal and posterior instead of anterior as in the more usual cases.

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When once the semilunar cartilage has been fractured or loosened it does not repair nor does it reattach itself, notwithstanding the use of the iodine

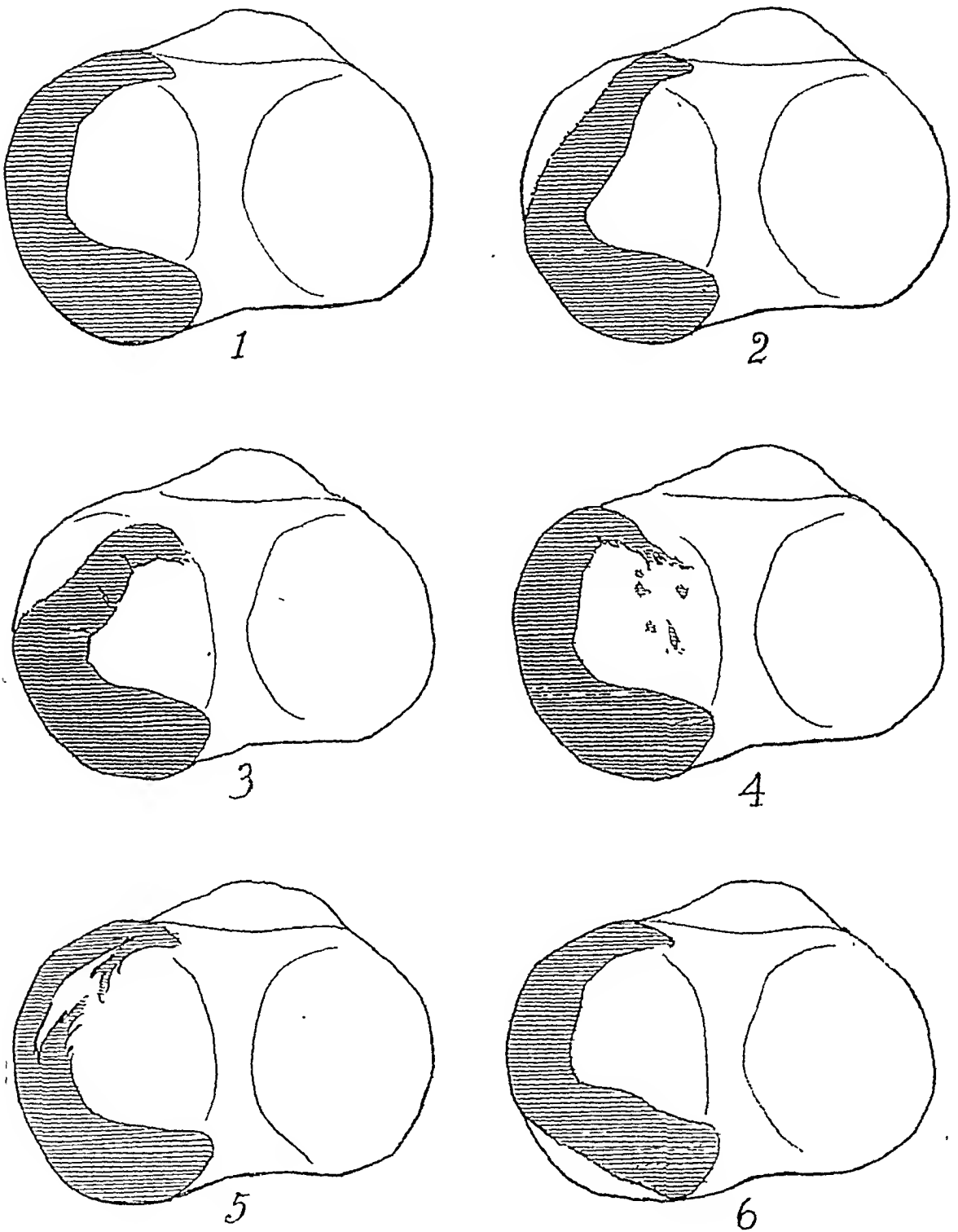


FIG. 7.—1. Normal position of the right internal semilunar cartilage. 2. Rupture of the anterolateral attachment of cartilage. 3. Detachment of the cartilage along its lateral anterior and internal aspects with multiple fractures and slight fragmentation at the tip. 4. Detachment of the tip with fragmentation. 5. Linear fracture of anterior portion of the cartilage with fragmentation. 6. Partial posterolateral detachment. (Figures 2, 3, 4, 5 and 6 represent five of writers' cases.)

injection method of Frauenthal. Complete removal of the entire cartilage in such a condition is the only rational method of treatment.

Fracture of the Patella is one of the very disabling injuries about the knee-joint. It may be a simple transverse fracture of the tip of the patella or through the body of the patella. In a number of the cases we have found multiple fractures both transverse and longitudinal. (Fig. 8.) The incomplete fractures which one occasionally sees in the very young need not be mentioned. Golay⁵ mentions a verticle fracture of the patella diagnosed by the X-ray in which there were not the ordinary symptoms of fracture of the patella other than sensitiveness over that bone and effusion in the

joint and a slight increase in its transverse diameters. Odermatt⁶ explains the great variance in fractures of the patella, by stating that in many cases there is a failure of the several centres of ossification to coalesce and because of this failure in union a fracture takes place more easily than it would in other normal bone.

The patella is a sesamoid bone lying in the tendons of the quadriiceps extensor with rather a meager blood supply. A fracture of this bone, therefore, heals slowly and often only by fibrous union. The usual fracture involves the lower one-half of the patella by reason of the nature of the injury. The management of such a fracture is primarily surgical and requires an open operation with accurate approximation and fixation of the fractured portion. The methods of such approximation vary with the experience of the surgeon. A



FIG. 8.—Multiple fracture of the patella.

greatly comminuted or crushed patella may call for complete removal, with a substitution of the extensor tendon or some other similar material. In the ordinary fractures a complete encircling of the patella by wire, kangaroo tendon or chromic catgut is the method of choice. In my operations I hold the fragments in close apposition with a large Lane bone-holding forceps, while the encircling suture is drawn up and tied. In several cases the Lambotte screw was utilized. It is drilled through the lesser fragments into the main portion of the bone, thus holding them firmly in approximation. Willems uses strong horsehair in suturing the fragments to each other. Albee used a transplant of bone from the tibia in some of

his cases, especially in the late fractures where there has been non-union. Some surgeons favor wiring the patellar fragments through drill holes passing through the various pieces. I believe that this procedure is unnecessary and only tends to weaken the bony structure. Cignozzi⁷ advises a gradual bloodless reduction of the fractures by the application of gauze figure-of-eight bandages and adhesive straps. This immobilization he continues for 48 hours, after which time the old bandages are removed and similar tighter ones substituted. Ten such applications are claimed to be sufficient to bring about a complete reduction. This method strikes one as being uncertain and palliative.

An early active and passive motion after wiring of the fracture is indicated to avoid fixations and unnecessary contractures of the tendons and capsule. This, however, must be carried on with great care under the immediate direction of the surgeon himself or a trained assistant. Fredet⁸ advises active motion by the patient at the end of several days.

The time required to bring about a union of bone depends upon the accuracy of the approximation, the degree of fixation and upon the patient's individual osteogenetic efforts. Some authors have tried to prove that one never gets an osseous union of these fragments. Clinically, however, we are interested only in a patella which is sufficiently strong to perform its function.

Fractures near or into the knee-joint offer many difficult problems for the surgeon. No other injury hazards the integrity of the joint more greatly. Therefore these fractures require special attention both from the standpoint of careful approximation and continuous and secure immobilization during the process of healing. In children and adolescents the fractures through the epiphyseal line and the epiphyseal separations are apt to bring about marked deformities which may interfere with the subsequent growth of the



FIG. 9.—Bullet fracture of the femur extending into the knee-joint. Application of the Parham-Martin band.

bone. The lower end of the femur is frequently seen separated from the shaft through the epiphyseal line. In the upper end of the tibia where the fibula acts as a side brace and where the tubercle on its anterior aspect strengthens it still more, the epiphyseal separations are not so common. Barth

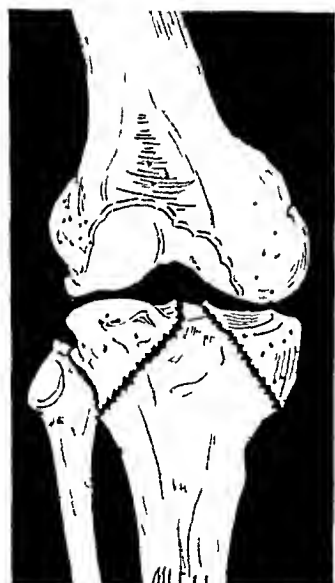
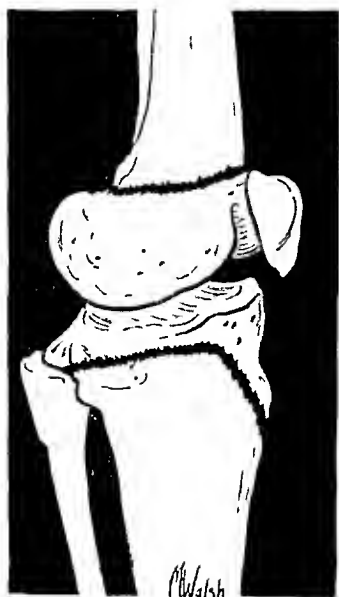


FIG. 10 —Scheme showing lines of fracture involving the knee-joint.

actly the same as the well-known healing process.

The simple fractures of femur in the adults are the transverse fractures above the condyles with Y or T fractures into the joint. The tibia offers fractures through the tuberosities, leaving the central point or intercondylar ridge intact, but frequently with depression of one or the other of the tuberosities with the resultant deformities. In one such case which came

assumed that in the region of the epiphyseal bone near the joints, entirely different healing processes obtain than is usual. Bier believes that the synovial membrane penetrates the cleft of the fracture thereby embarrassing the healing.

Axhausen⁹ performed animal experiments to disprove these theories. He took out wedge and thin disk-shaped pieces as well as tiny pyramidal-shaped pieces of cartilage from different portions of the articular surface and replaced them loosely. In eight experiments in which deep impression fractures of the joint surfaces were produced, the fragments entered into a firm bony union in every case. The process of healing in the bony portion was ex-

under my observation a fracture through the external tuberosity permitted that portion of the articulating surface to drop three-eighths of an inch below its normal position. The knock-kneed deformity was obvious and it was necessary to raise the tuberosity to its normal position by open operation. Aside from the disturbance of the joint by uneven articulating surfaces there enters another factor or complication, namely, the hemorrhage into the joint cavity. There is an immediate effusion of blood and serum into the joint and the traumatic exudate about the line of fracture causes the formation of the plastic exudate upon the joint surface and synovial membrane. If the joint is not sufficiently immobilized the formation of exudate continues and hazards subsequent motion. If the joint is kept immobilized too long this plastic material becomes organized and ankylosis results. We must, therefore, re-approximate and immobilize perfectly and begin motion as soon as possible if we wish to avoid inter-articular fixation.

The greatest difficulty is encountered when one attempts to replace the fractured ends which lie within the joint cavity. Traction, counter-traction and manipulation under the fluoroscope yields the best results but even with all of these methods it occasionally becomes necessary to do an open operation for proper reduction. Ligamentous and tendinous attachments to the short fractured ends often bring about distortions of the fragments which require special attention. Placing the limb in such a position as to relax the traction of the tendons is imperative. Various types of screws, staples, nails and wires may be utilized in the proper mobilization of fragments.

In the compound fractures, one has in addition to the usual difficulties the great danger of infection. A suppurative process when once well established in such a joint is not only almost certain to produce an ankylosis but usually demands a removal of the free pieces of bone. Recent experience has taught us that the immediate opening of the joint according to the method of Willems, applying the principles of débridement, gives the very best results. Eising¹⁰ describes this method very clearly by stating that in the treatment of compound fractures into the joint this principle must be applied with primary suture of the joint capsule, and almost immediate post-operative active motion where the fracture does not involve the articulating surfaces. The treatment of such cases by the Carrel-Dakin method is indicated when the infection is superficial and where the hospital facilities are adequate and where nurses and assistants are trained to carry out the daily details as outlined by the originators of this method. It is contra-indicated in the joint or in deep pockets or pouches filled with septic material. It is entirely inadequate in pyocyanous infections and where deep tissues are involved. The same objections obtain for the use of other antiseptic solutions. There is only one treatment for a well-established infection in and about the joint—free and dependent drainage.

The fractures into the joint caused by bullets or other missiles of high velocity are less apt to be infected than the ordinary compounding injuries.

In one such case where the bullet had penetrated through the popliteal space and had partially shattered the lower end of the femur I obtained an excellent result without infection by waiting for ten days until nature had completely walled off the injured area and then through a lateral incision removed the bullet and held the splintered bone together with a Parham-Martin band. (Fig. 9).

In the fractures in and about the joint four fundamental laws must be strictly observed:

1. The peripheral fragment must always be brought in correct apposition with the central fragment.
2. Reduction must be affected by traction, counter-traction, manipulations, and relaxation of the attached tendons or if necessary by open operation.
3. The reduced fragments must be secured in approximation.
4. When infection exists drainage must be dependent and efficient.

Dislocations.—Dislocations simple or compound with or without fractures must be managed along the same lines as outlined under fractures. The dislocations must always be reduced under anæsthesia if we wish to avoid extensive traumas to the articulating cartilaginous surfaces. The practice of some writers to permit fractured bones to heal before making the reduction does not commend itself to my judgment.

Puncture Wounds.—In the small puncture wounds about the knee-joint the treatment of rest and immobilization frequently suffices to bring about a good result. On the other hand, if the puncture or lacerating wound was of considerable size and has carried with it infectious material there seems to be but one method to adopt, namely that of immediate opening of the knee-joint with thorough cleansing and primary suture. By primary suture I mean a closure of at least the synovial capsule. Drainage is then instituted down to this joint with only partial closure of the fibrous capsule and skin. In this way one often avoids the pocketing and extension of infection which occurs so often in cases completely closed without drainage. Immediate immobilization is the next important step. However, there are those who still believe in the absolute immobilization treatment following laceration of the joint. Before the war, simple drainage with fixation of the joints by splints and casts was the rule. Webb¹¹ reports a series of 208 cases treated in this manner with 52 deaths, 13 secondary resections and 14 subsequent amputations in addition to numerous cases of ankylosis. In a series of 328 cases treated by mechanical cleansing of the joint followed by primary suture and active mobilization there were 312 recoveries without ankylosis. Those cases which do not come under the care of the surgeon until infection has become well established must, of course, be treated by efficient drainage in the most dependent position and usually with mobilization of the joint. The pus which has burrowed under the muscle and fascia sheaths or has become pocketed in the popliteal space or walled off in other portions of the joint must be opened and completely evacuated. The lacerated wounds of the joint

in civil practice should yield even better results than those obtained during the war. The patient is usually brought into the hospital without delay and comes under the management of the surgeon who follows up the case without interruption. The patient need not be moved from hospital to hospital but is usually kept in the same ward or room under the same supervision. In most instances the infection in cases in civil practice is not so virulent as those obtained in the battlefield and will naturally yield more quickly to the treatment.

When ankylosis occurs with the leg in a fixed or twisted position, motion can be restored by an arthroplastic operation. The mobilization of the knee-joint is such a difficult procedure and involves so many surgical principles that it must be undertaken only by those who have had a large experience in operation upon joints.

Free joint bodies or joint mice have their origin (1) from fractures in which small particles of bone have become partially or entirely detached at the time of the accident or were entirely separated from their attachment by the subsequent mobilization efforts of the joint; (2) very frequently portions of the semilunar cartilages detach themselves by comminution of the cartilages or by the nipping action of the femur on the tibia; (3) in cases of extensive hypertrophic villous synovitis a mass of fibrous hypertrophied tissue detaches itself and floats about in the joint often causing symptoms of locking or otherwise interferes with normal flexion and extension; (4) many authors believe joint mice to have their origin only in cases of osteochondritis dissecans, an inflammatory process with varying cartilage and joint surface changes producing loosened portions of cartilage and periosteum. Personally I believe that osteochondritis dissecans as an independent process does not exist, but believe that the histologic pictures are the expression or result of a reaction of the joint tissue to a trauma under certain anatomic and mechanical conditions. Joint mice when sufficiently large as to cause incapacity must be removed by open operation. They are very elusive and because of the frequently associated hydroarthrosis may float into any part of the joint. Those most difficult of removal lie in the posterior pouch of the knee-joint behind the condyles. This recess is divided by a median septum which does not permit of a thorough search excepting through a postero-lateral incision on both sides of the joint. Osgood advises an incision through the popliteal space which is efficient but difficult and rather hazardous in the hands of the general surgeon. Very few of these foreign bodies can be visualized in the X-ray picture and it has been necessary to utilize various methods of fixing them. When once they are localized by the patient or palpated through the skin by the examining surgeon a transfixing needle holds the foreign body in position until it can be removed through an incision. Occasionally it is necessary to do a wide open arthrotomy for the removal of these bodies. I have seen one excellent surgeon resort to the extreme measure of dividing the patella in its long axis, laying

the joint wide open so that he might find a single body which he had not been able to find through a smaller incision.

The subject of traumatic flail joints opens a new field of surgical management. Mühlaus¹² describes a flail joint as a pathologic condition in which there is the ability of abduction and adduction of the lower limb by maximum contraction of the quadriceps muscle. He distinguishes three forms, first the "totter" joint, second the "pendulous" joint, third the "flail" joint. Differentiation of these types depends upon the extent of involvement. They are frequently observed following fractures and shortening of the femur, in which the attachments and insertions of muscles or tendons are brought nearer together.

The management of all knee-joint injuries resolves itself into four distinct equations:

1. A proper diagnosis of the lesion made from the history of the case and physical and X-ray examinations. A study of the mechanism of the accident and a thorough knowledge of the anatomy of the tissues involved are necessary to enable the surgeon to make his decision. The diagnosis by X-ray should be made only from a stereoscopic picture.

2. The surgical procedure involves a careful reapposition of injured tissue whether it be osseous, cartilaginous or tendinous and if this is not feasible, a removal of that portion which cannot be utilized or is foreign to the joint and if necessary a substitution of bone or fibrous tissue from some other part of the body.

3. Operative measures upon a joint must be carried out with the strictest aseptic technic and at such time when nature's walling off or cofferdaming is complete. There is no longer any reasonable excuse for introducing into the joint the operator's finger, any instrument, appliance or sponge which is not absolutely sterile. The joint tissue is as sensitive and as unprotected against infection as the eye and reacts badly to excessive manipulation or trauma.

4. The after-care requires the use of such appliances as are necessary to hold the tissues in position. Active and passive motion must be sufficiently early to avoid excessive adhesions and not so late as to permit peri-articular fixations to form. The application of physiotherapeutic measures, especially diathermy and heliotherapy, must be utilized to the fullest extent.

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KNEE-JOINT INJURIES

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(The figures 3, 4 and 5 are from the author's cases reported in The Surgical Clinics of North America and are used here through the courtesy of the W. B. Saunders Company.)

ARTHROPLASTY OF THE KNEE*

BY WILLIS C. CAMPBELL, M.D.

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MOBILIZATION of an ankylosed knee is generally admitted to be more difficult than parallel conditions in other joints, which is probably due to the fear of instability and that no routine procedure conforms to all cases. Also the chance of success, which has been offered in the past, is so small that few have submitted, in consequence, many surgeons have condemned operative measures from failure in a limited number of cases.

In order that any surgical operation become generally accepted, success must be attained by comparatively simple after-treatment, without incurring

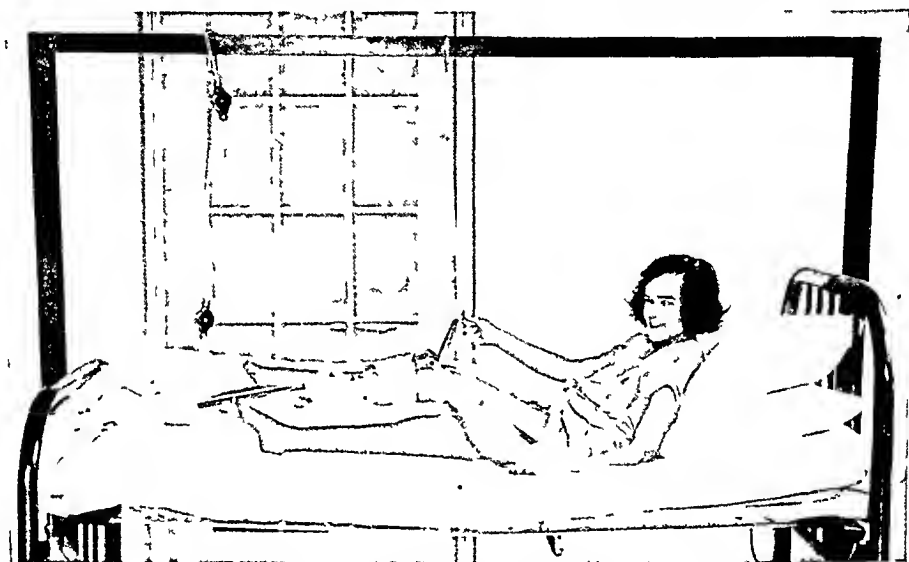


FIG. 1.—Demonstrating apparatus for active and passive motion under control of patient, which was begun on the eighth day after operation.

enormous expense. The consensus of opinion, at present, is that long-continued expert physiotherapy, under the direct surveillance of the surgeon is essential. My opinion, regarding this statement, has been completely reversed within the last few months, and believe that any well-selected case can be offered reasonable chance of success if intelligent coöperation, on the part of the patient, is secured.

In a previous article, *Minnesota Medicine*, September, 1922, I stated that: "In only selected cases should operative procedures for mobilization of ankylosed joints be considered. The following pathological conditions, encountered in such joints, decrease the chance of success or actually contra-indicate surgical measures:

* Read before the Orthopaedic Section of the New York Academy of Medicine, June 19, 1923.

1. Tuberculosis: In no case should a joint be entered for the purpose of mobilization when tuberculosis was the causative agent in the production of ankylosis. Undoubtedly it might be possible to obtain excellent results in some instances, but the probability of "lighting up" a latent tuberculous process is well known and should be sufficient warning.

2. In those in which a destructive osteitis, in early life, has obliterated the epiphyses, a materially shortened extremity is encountered. Mobilization

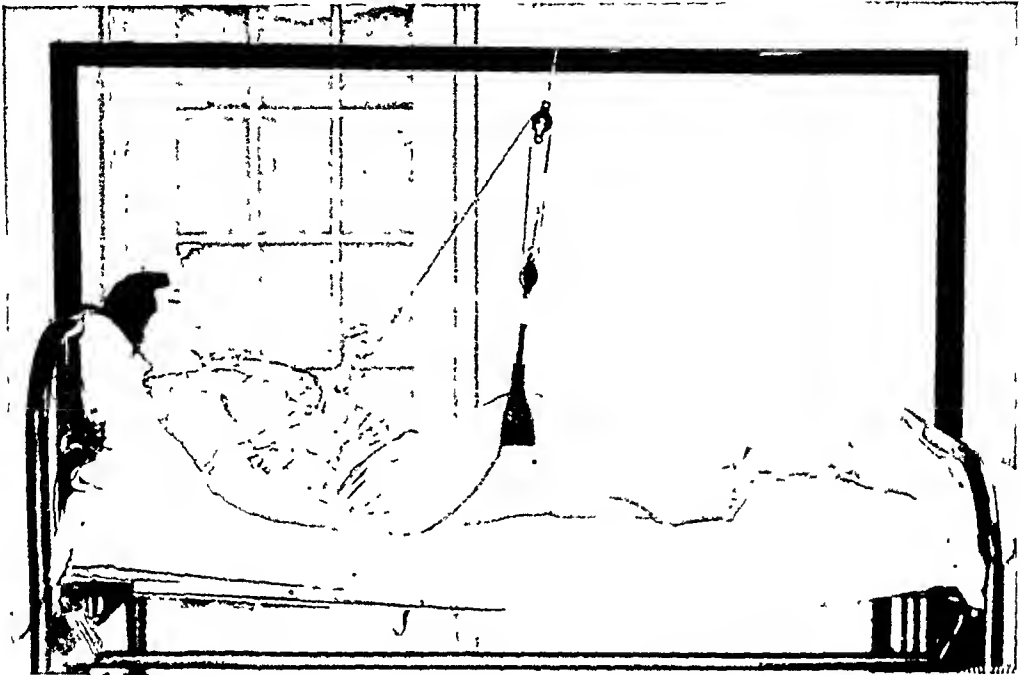


FIG. 2.—Demonstrating apparatus which patient used at home, at the end of six weeks.

of such a joint obviously would not be of sufficient advantage to justify the means.

3. Extensive scar-tissue, binding the skin to the bone, may render the procedure unsuitable, unless preceded by plastic measures.

4. Physiological rearrangement of structure. Extreme muscular atrophy with reorganization of bone structure, as is seen when a bony ankylosis has existed over a long period of time. The medulla may pass through the joint, producing a canalization with rearrangement of the lamellæ. The spongy is transformed into dense bone, making one continuous bone from the ankle to the hip with one canal. In such an instance, sufficient base would not be found to reconstruct a functional joint; besides, the open medullary canal might be a factor to be considered—and, the muscular apparatus being extremely atrophic, the restoration of same would be difficult.

5. Old dense eburnated bone, when found for a considerable distance on both sides of the joint, is not favorable soil for reproduction of a movable joint. Such a condition is usually caused by an extensive virulent osteomyelitis, the result of which is low-grade bone tissue, which bears the same relation to normal bone that scar-tissue does to normal soft tissues. In fact, healthy, spongy bone should compose the articular surfaces of the new joint. Conse-

quently, the chance of success is small, when the structure of the bone has been transformed for one or more inches beneath the joint line.

In ankylosis surgical operations should not be employed for the purpose of mobilization, unless the result of only two causative agents: (1) Traumatism—crushing of the joint surfaces, tearing of the periosteum, or multiple fractures, followed by bony ankylosis; (2) acute infectious arthritis due to staphylococcus, streptococcus, pneumococcus, gonococcus, etc. These organisms erode and disintegrate the cartilages and the superficial bone, unless the infection begins in the shaft, and then we have an extensive osteomyelitis and not a localized arthritis."

The pathology of ankylosis is well known and has been described in previous contributions. The



FIG. 3.—Case XXV. Complete bony ankylosis, previously reported showing extension four and one-half years after operation.

operative methods in fibrous and bony types are indential and require no differentiation. In remodelling the knee-joint no routine technic is applicable to all cases, but must be modified to accommodate the following conditions:

1. Position, extension, flexion, flexion and external rotation and valgus.

2. Distribution of ankylosis. (a) Fusion of patella and femur with tibio-femoral

articulation apparently normal. (b) Tibio-femoral fusion with freely movable patella. (c) Hemi-ankylosis—one condyle and its articulating tuberosity fused with the other half of the joint apparently intact. (d) Pan-ankylosis—complete bony fusion of patella, femur and tibia, by far the most frequent occurrence.

OPERATIVE TECHNIC IN EXTENSION

The skin incision is an inverted U, beginning just below the inner tuberosity and passing about one inch above the patella, terminating at the outer tuberosity, a straight incision of four or five inches is made at right angles, about one inch external and parallel with the quadriceps tendon, differing from the Putti approach in that the vertical portion is not directly over the tendon—a distinct advantage. After cutting through fat and fascia, dissection is made over the quadriceps tendon, which structure is lengthened by the common Z-plastic method, leaving the outer half attached to the patella below, which will later be of value in closing. With a large osteotome the union between the patella and femur is severed. The incision is then carried downward to the bones on both sides, as far as the upper extremity

of the tibia. The tibio-femoral union is completely severed, no attempt being made to forcibly flex, even in fibrous cases, until this is accomplished, for fractures of the lower extremity of the femur are easily sustained, and may seriously complicate. The knee is then fully flexed, giving free access to the raw bony surfaces of the tibia and femur. In a normal individual, who has no lateral play in the sound knee (previously noted), from one-half to one inch of bone is removed from the femur. The surface is then made convex from before backward and on the same plane from side to side, so that the femur presents one large condyle. The intercondylar notch is obliterated in the process. As small an amount of the upper extremity of the tibia, as possible, is excised in order to reach healthy spongy bone. With a large gouge this surface is made slightly concave from before backward, one large shallow cavity for articulation with the one condyle of the femur, two points of articulation instead of the normal four. No attempt is made to reproduce spine of tibia or intercondylar notch of femur, for there will be no crucial ligaments to prevent lateral displacement, which may easily occur, bringing irregular surfaces together with obvious mechanical damage, when motion is instituted. The raw surfaces are next approximated and the alignment of the entire extremity tested. If varus or valgus, more bone is removed from each surface until a perfectly straight hinge is formed. Especial care should be taken not to produce valgus regardless of the position of the normal limb. Future weight-bearing must be direct and in a straight line. The knee is next hyperextended, when there should be at least thirty degrees. If this cannot be attained more bone should be removed except in individuals with very lax joints or atrophic musculature, when ten or fifteen degrees hyperextension is sufficient.



FIG. 4.—Case XXV. Showing flexion four and one-half years after operation.

Our attention is next directed to the patella, the posterior surface is removed to a very thin layer, just sufficient to be consistent with tensile strength. The lateral margins are trimmed for one-fourth of an inch so as to allow the periosteal and tendinous fibres to fold backward along the edge of the posterior surface. A large rasp renders all surfaces smooth. All recesses are carefully searched and every particle of loose bone removed. Just below the patella and on the posterior aspect of the patella tendon will be found a mass of fat, and, at times, a layer of synovial membrane, which is severed at the

junction with the tibia and dissected from below upward into a flap with a broad pedicle which is stitched with number one chromic catgut, to the margin of the periosteal and tendinous fibres above described, along the inner and outer edge of the posterior surface. This is an important step, for in those cases in which ankylosis recurs, adhesion begins between patella and femur and is the most difficult problem encountered in restoring mobility.

If the individual is muscular or fat a pedunculated flap may be obtained from the fascia lata external to the quadriceps, the pedicle of which must be broad, and the capsule incised, if necessary, to permit easy passage without constriction. With the deep surface turned out this is carried across the outer femoral condyle and attached to the inner condyle and posterior capsule. Recently we have transplanted the free fascia lata from the outer aspect of



FIG 5.—Case I. Patello-femoral fusion with loss of quadriceps tendon. Routine arthroplasty with plastic restoration of quadriceps from vasti.

the opposite thigh, taking a very large sheet, four or five inches in width by eight or ten inches in length, turning the deep surface out, as one of the functions of this membrane is the free easy play of the muscles beneath. This sheet of fascia is placed over four or five inches of the anterior aspect of the femur and attached muscles, being anchored above to the deep fibres of the muscles, it then passes over the condyle of the femur and is stitched to the posterior capsule, as high as possible, after which it drops downward along the posterior capsule and finally forward to the anterior surface of the tibia, all free edges are stitched with continuous chromic catgut well over the margins of the joint. The joint remains flexed sixty degrees for closure, as the capsule may be contracted, and if closed in extension free flexion would not be permitted, thus defeating the purpose of the operation. The inner portion can always be united as the vastus internus extends lower and there is more resiliency in the soft parts on the inner side. For this reason the quadriceps tendon is severed above, through the outer half, and below, through the inner half, so that the outer half is attached to the patella. If the edges of the capsule cannot be brought together in flexion, a flap of fascia or muscle may bridge the defect, as it is absolutely essential to restore a closed intact mechanical joint. The quadriceps tendon, fascia and skin are sutured in routine manner, using chromic gut for deep structures and dermal suture for skin.

ARTHROPLASTY OF THE KNEE

TECHNIC IN COMPLETE ANKYLOSIS IN FLEXION

When ankylosis occurs in flexion the anterior structures are redundant after removal of sufficient amount of bone, however, severence of the posterior capsule may be necessary, though stripping of the periosteum above and below, for one or two inches, has been found sufficient. The quadriceps tendon can be retracted to the inner side without dividing, which is an obvious asset. The greater the degree of flexion, the larger the amount of bone excised.

TECHNIC IN FUSION OF PATELLA AND FEMUR

In fusion between patella and femur, with an apparently normal tibio-femoral articulation, the position is always extension or possibly very slight flexion. The patella is treated as above described, with a broad sheet of fascia lata, from the outer aspect, folded beneath the patella and quadriceps tendon, being retained *in situ* by stitching to the vastus internus, the deep surface of the fold facing the patella and quadriceps. This is not a pedunculated strip, but a living viable fold. When scar-tissue invades, a free fascial transplant is taken from the opposite thigh. If the capsule space is not of sufficient size to allow flexion, plastic adjustment is required as above described.



FIG. 6.—Case I. Showing degree of flexion two years after operation.

TECHNIC IN TIBIO-FEMORAL FUSION WITH FREELY MOVABLE PATELLA

When tibio-femoral fusion occurs, with a freely movable patella, the incision should be U-shaped across the patella tendon. The patella tendon is lengthened by Z-plastic method, after which the new joint is remodeled as above described. This condition is not a sequela of acute infectious arthritis, but, usually, the result of a virulent infectious osteomyelitis, with direct bone infection across the joint space, the anterior portion of the joint being protected and walled off by inflammatory exudate, a counterpart of which is so frequently seen in the abdominal cavity.

TECHNIC OF HEMI-ARTHROPLASTY

Occasionally a considerable portion of the joint surface is intact and may be conserved. This may frequently be accomplished in the elbow and shoulder, as described in *ANNALS OF SURGERY*, November, 1922, vol. lxxvi,

No. 5, as hemi-arthroplasty. After remodelling the affected portion a pedicle flap is usually quite sufficient.

There are several points to be elucidated and emphasized. 1. The amount of bone to be removed depends on the position of the limb, the contracture of the soft parts and the musculature of the individual. Roughly speaking, from one to one and one-half inches, though possibly as much as two inches has been removed. A satisfactory degree of hyperextension must be secured.

2. *Inequality*.—Shortening has never been of practical disadvantage nor a question of consequence, if a movable joint is attained. If over two inches a stiff joint, in an improved position, would be more satisfactory.

3. *Instability*.—An unwarranted fear if one remains within the bounds of reason and does not remove too much bone from the pedestal—the tibia.



FIG 7.—Case II. Complete ankylosis. Extension after third arthroplasty.

4. *Material Interposed*.—

When no substance is interposed ankylosis usually recurs regardless of the efficiency of the after-treatment. A tissue of some type should be inserted between the denuded surfaces, for it is an undisputed fact that fascia, muscle and periosteum, between fragments of fractured bones, are a possible cause of pseudo-arthrosis. Animal

membranes have been employed but possess the disadvantage of foreign-body irritation, invite infection and may be extruded. Either the pedunculated fascia lata or the free fascial transplant should be selected as indications demand, being careful to place the deep layer on the surface of the joint as described. The fascia lata is not only desirable, from its strong fibrous composition, but the deep surface is smooth and glistening and its function is the easy play of the strong muscles of the thigh. A histological examination of this membrane was made by Prof. O. W. Hyman, of the University of Tennessee, which showed that the deep fibres were parallel, having the same structure as tendon tissue, being connected with the muscles by loose areolar tissue.

There have been no serious complications. Infection will occur in a high per cent. on account of extensive raw bony areas being so near the surface with the incident copious drainage. Even a severe infection with thorough Dakinization does not necessarily prevent an excellent result. Ankylosis may recur in spite of most careful after-treatment.

There has been much speculation as to the physiology and histology of such a joint. We have operated four times for recurrent ankylosis, after

arthroplasty, once in two cases, and twice in one, about six months elapsing between each operation. In three of these cases there was about ten degrees voluntary motion. In these we found the patella adherent through scar-tissue. There were fibrous bands connecting the tibia and femur, alternating with areas of cartilage and heavy fibrous tissue on the articular surface. The superficial spongy bone was dense and hard. No evidence of bursa, hygroma or synovial membrane could be macroscopically or microscopically demonstrated. We have had no occasion to incise a knee-joint in a successful case, but in all probability the articular surfaces, after an elapse of one or more years, are encrusted with an atypical fibro-cartilage, supported by a dense layer of bone, the fibrous cells, in time, being flattened under pressure and may assume, by functional adaption, an endothelial type secreting sufficient fluid for lubrication. In fact, it is hardly conceivable that any other process, consistent with joint function, could occur.

THE AFTER-TREATMENT

As soon as the operation is completed the limb is placed in a Thomas splint, with a joint at the knee, and a hoop of steel connected just above and anterior to the knee-joint. A rope is attached to the centre of the hoop and overhead to a



FIG. 8.—Case II. Showing degree of flexion.

simple wooden frame. A second rope is attached to the lower extremity of the Thomas brace, which passes directly upward to the wooden frame, through a series of pulleys, to the head of the bed, where it is attached. By adjusting these two, any desirable angle may be maintained and by gravity of the leg, under direct control of the patient, passive and active motion instituted (Fig. 1). The limb is first placed in the extended position with moderate traction, except in patello-femoral fusion, when flexion is desirable. No motion is instituted until local reaction has subsided, which requires about eight or ten days. Active motion is encouraged with special attention to the development of function in the quadriceps. Passive motion is carried out by the patient, who is given the end of the rope, which is detached from the head of the bed, and by gravity of the leg flexion is made. The subject soon finds that considerable motion is possible without pain. The splint is removed in about six weeks, depending on the stability of the joint, and a simple overhead sling, with block and tackle, substituted (Fig. 2), when walking on crutches is permitted. Weight-bearing is gradually increased with care to avoid reaction. In resistant cases brisement forcé is of value, if

cautiously employed, under nitrous monoxid, with full extension and only ten degrees increase in flexion on each occasion. The value of physiotherapy should not be underestimated, though, by no means essential to success, if the measures above described are closely followed by the patient. Total disability is expected from two to three months, partial disability for six months depending upon the occupation of the individual.

Complete extension is essential, sixty to ninety degrees flexion gives the best functional results and a member which can be used for all practical purposes.

In an article in *Jour. Ortho. Surg.*, September, 1921, vol. iii, No. 9, twenty-four cases were reported, of these only thirteen were suitable for final analysis, nine of which obtained voluntary motion, but only five of sufficient degree to be classed as satisfactory or excellent. Since



FIG. 9.—Case III. Complete bony ankylosis showing degree of extension three months after arthroplasty.



FIG. 10.—Case III. Showing degree of flexion.

this time we have encountered a larger number in a shorter space of time, which has offered an opportunity to make a more careful analysis of the condition, and to formulate procedures and routine after-treatment with a substantial increase in the percentage of satisfactory results.

Since the previous reports, above mentioned, we have operated sixteen knees for the purpose of restoring motion, making a total of forty arthro-

plasties. Twelve of the sixteen had a solid bony ankylosis of patella, femur and tibia, two fusion of patella and femur, two fibrous ankylosis. Eight were in malposition of flexion with or without external rotation; eight were in extension. The ages ranged from thirteen to thirty-six. In two the etiological factor was compound fractures with infection, the remainder, sequelæ of acute purulent infectious arthritis. Radiographs in all showed normal spongy bone, a short distance beneath the joint line. In three no tissue was inter-

ARTHROPLASTY OF THE KNEE

posed between the articular surfaces. In two of these ankylosis recurred though very careful after-treatment was rigidly carried out. One obtained a very successful result, 90 degrees free motion. Of the sixteen, ten were successful, the degree of voluntary motion secured was 60, 80, 80, 90, 60, 80, 50, 40, 40, and 30. Pedunculated fascial flap was interposed in four, free fascial transplant in five and no tissue in one. Two, in which no material was interposed, were failures. In four it is too early to reach conclusions. There were ten successful and two failures, $83\frac{1}{3}$ per cent. In two, with ankylosis of seven and eight years' duration, a slight laxity prevails, but should improve with muscle training. Sufficient time has not elapsed to determine the permanency and durability, consequently, this report cannot be received as conclusive, but encouraging, however, from past experience we would conclude that the range of motion and function will be materially increased in all successful cases. Two cases have been under observation for four or five years, respectively, each of which has practically a normal knee—one is on constant duty as a nurse (Figs. 3 and 4).

Of the sixteen, infection occurred in four, three of these required Dakinization, counter-drainage, etc., but obtained a successful termination with free voluntary motion, which proves that even infection may not inhibit the result.

One of the successful cases was in a boy thirteen years old, but care was taken not to disturb the epiphyses. Such procedures in children require constant supervision of an indefinite period.

My first report was by no means encouraging but from results obtained, especially during the last year, arthroplasty of the knee is justifiable in well-selected cases, with an excellent chance of attaining satisfactory motion.

All cases were white adults with one exception, a white boy of thirteen. Only the essential facts are related in the following:

CASE REPORTS

CASE I.—Mr. B. W., age twenty-one, cause, compound fracture of the femur with complete loss of quadriceps tendon, duration two years, bony ankylosis patella and femur, tibio-femoral articulation apparently normal, excessive scar-tissue in thigh from prolonged infection, position extension. Operation, April 8, 1921. Routine procedure except that prepatella bursa was dissected out and placed over denuded surface of patella. Quadriceps tendon reconstructed from a strip of muscle tissue about one inch in diameter, from each vastus muscle. A severe infection ensued requiring Dakinization for three weeks, when routine after-treatment, above described, cautiously instituted solely by the patient himself. Drainage persisted for six months. Result full extension 60 degrees flexion. (Figs. 5 and 6).

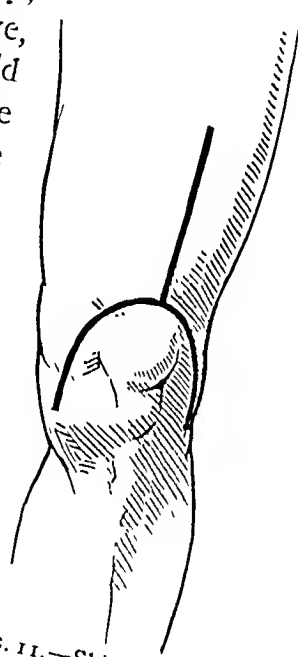


FIG. 11.—Skin incision, arthroplasty of the knee.

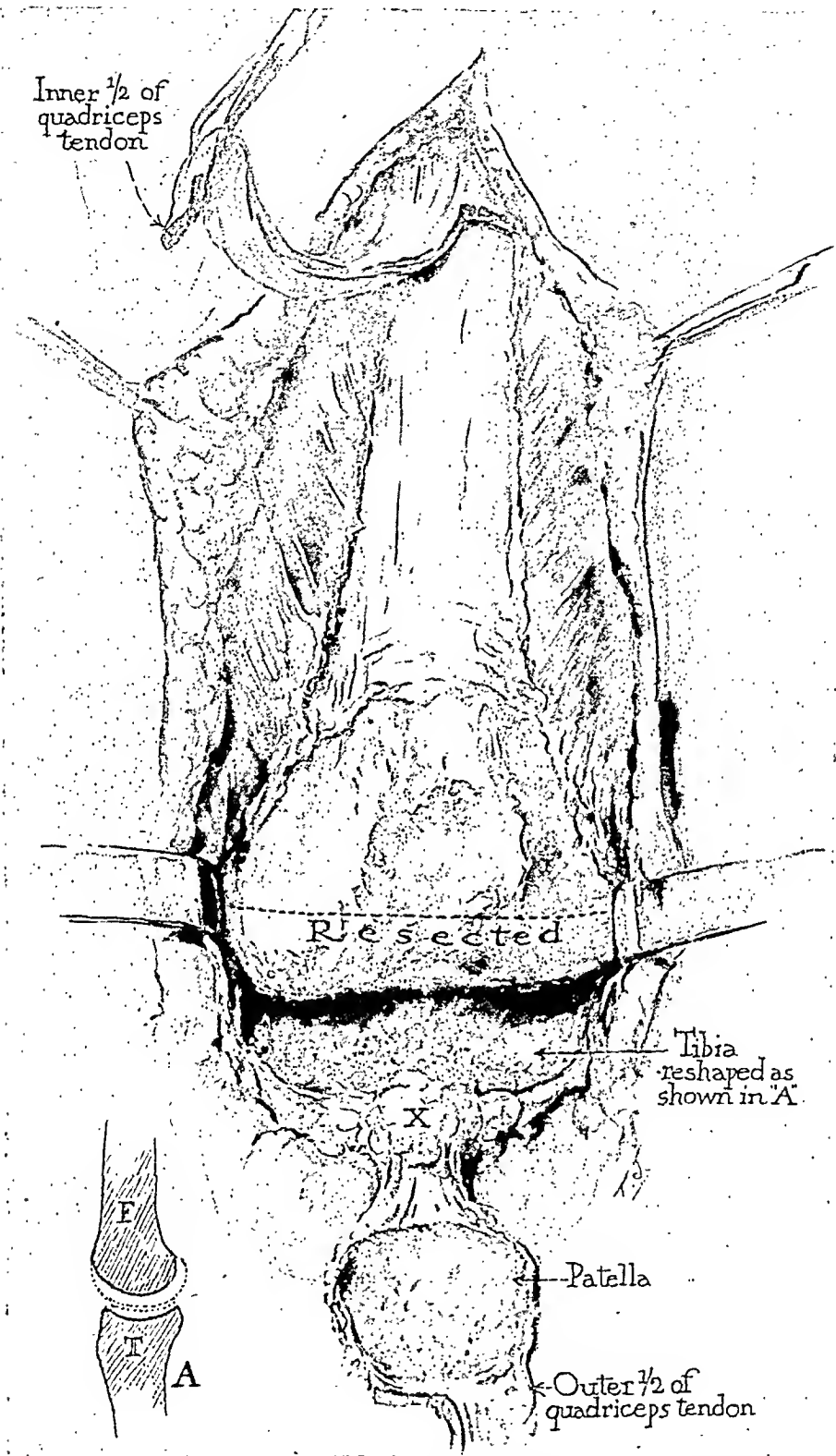


FIG. 12.—The making of one large condyle of the lower extremity of femur and one shallow cavity of the upper extremity of the tibia. As much of patella removed as possible.

ARTHROPLASTY OF THE KNEE

CASE II.—Mrs. M. H., age twenty-three, cause, acute infectious arthritis. Two previous arthroplasties with failure, duration two years, complete bony ankylosis. Third arthroplasty May 26, 1921, free fascia lata transplanted. On the third day aborted, on the sixth day walked about room on Thomas splint which was followed by infection. Routine after-treatment by patient as soon as acute symptoms subsided, one gentle brisement forcé at the end of three months. Result—complete extension 80 degrees flexion, no instability after three arthroplasties. (Figs. 7 and 8.)

CASE III.—Mrs. R. C., age twenty, acute infectious arthritis, complete bony ankylosis, duration one year, position extension. Routine procedure June 14, 1922. Pedunculated fascial flap interposed, physiotherapy two weeks, otherwise after treatment solely by patient. Result, slight hyperextension, 50 degrees flexion. (Figs. 9 and 10.)

CASE IV.—Mr. M. C. B., age twenty-two, acute infectious arthritis, complete bony ankylosis, duration seven years, position 90 degrees flexion. Routine procedure, August 10, 1922, free fascial transplant, after treatment routine by patient, no physiotherapy. Result complete extension 70 degrees flexion, slight instability necessitating a brace which should be discarded in a few months.

CASE V.—Miss M. L., age thirty-six, very fat, acute infectious arthritis, complete bony ankylosis, duration two years. Position 30 degrees flexion with external rotation. Routine procedure April 12, 1922, no material or tissue interposed, physiotherapy four months. Result complete extension 80 degrees flexion.

CASE VI.—M. C., age twenty-nine, thin, frail, acute infectious arthritis, complete bony ankylosis, position extension, duration eight years. Routine procedure but only ten degrees hyperextension on account of weak musculature, free fascia lata transplanted, physiotherapy six weeks when discontinued on account of physical condition. One gentle brisement forcé. Result full extension 90 degrees flexion, slight instability which is rapidly improving with increased muscle function.

CASE VII.—Mrs. M. C., age thirty, acute infectious arthritis, pan-articular fibrous ankylosis, 20 degrees free motion. November 1, 1921, modified procedure with conservation of joint surface, leaving areas of cartilage intact. Pedunculated fascial flap interposed, severe infection, 50 degrees free motion with full extension, routine after-treatment by patient.

CASE VIII.—I. W., boy, age thirteen, acute infectious arthritis, complete bony ankylosis, duration two years, position 75 degrees flexion. March 2, 1922, routine procedure with care not to invade epiphyses. Pedunculated fascial flap interposed, marked tendency to recurrence, gentle brisement forcé otherwise routine after-treatment by patient. Result 40 degrees free motion with mild genu valgum.

CASE IX.—Mrs. G. W. S., age twenty-five, acute infectious arthritis, duration one year, position 60 degrees flexion, April 10, 1922, routine procedure with no tissue interposed, physiotherapy two weeks when recurrence was inevitable and patient dismissed with correction of deformity.

CASE X.—Mrs. N. K., age twenty-two, acute infectious arthritis, bony ankylosis between patella and femur. Fibrous between external condyle of femur and external tuberosity of tibia, inner half of joint a few adhesions, cartilages intact, about ten degrees painful motion. Duration nineteen years, position 20 degrees flexion. November 18, 1921, hemi-arthroplasty with pedunculated fascial flap in external half of joint and between patella and femur. Routine after-treatment with physiotherapy, result complete extension 50 degrees flexion.

CASE XI.—Miss R. J., age nineteen, acute infectious arthritis, complete bony ankylosis, duration eleven years, position 70 degrees flexion. April 14, 1922, routine procedure without interposition of material between joint surfaces, expert

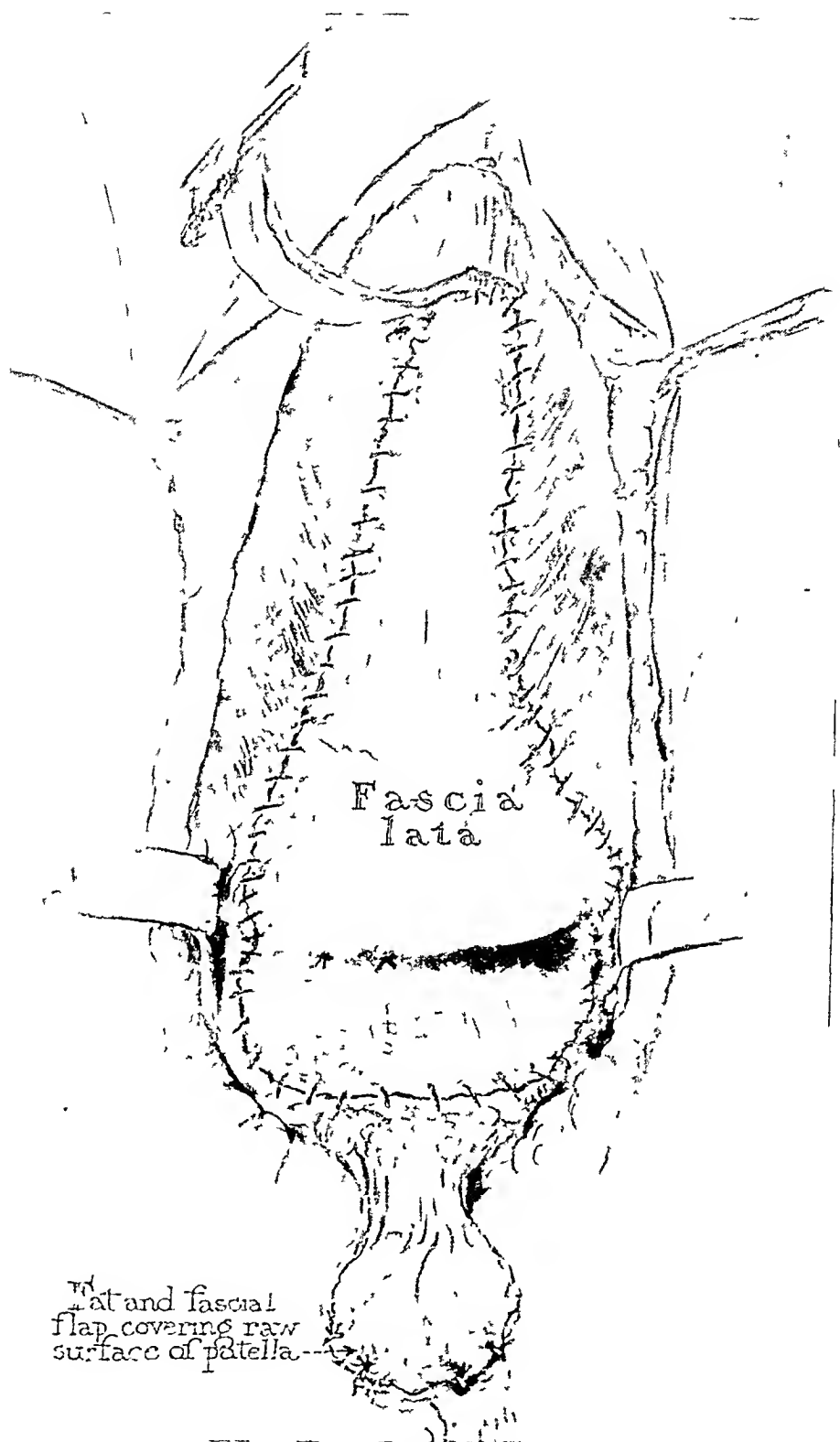


FIG. 13.—Anterior view after interposition of fascia lata from opposite limb.

ARTHROPLASTY OF THE KNEE

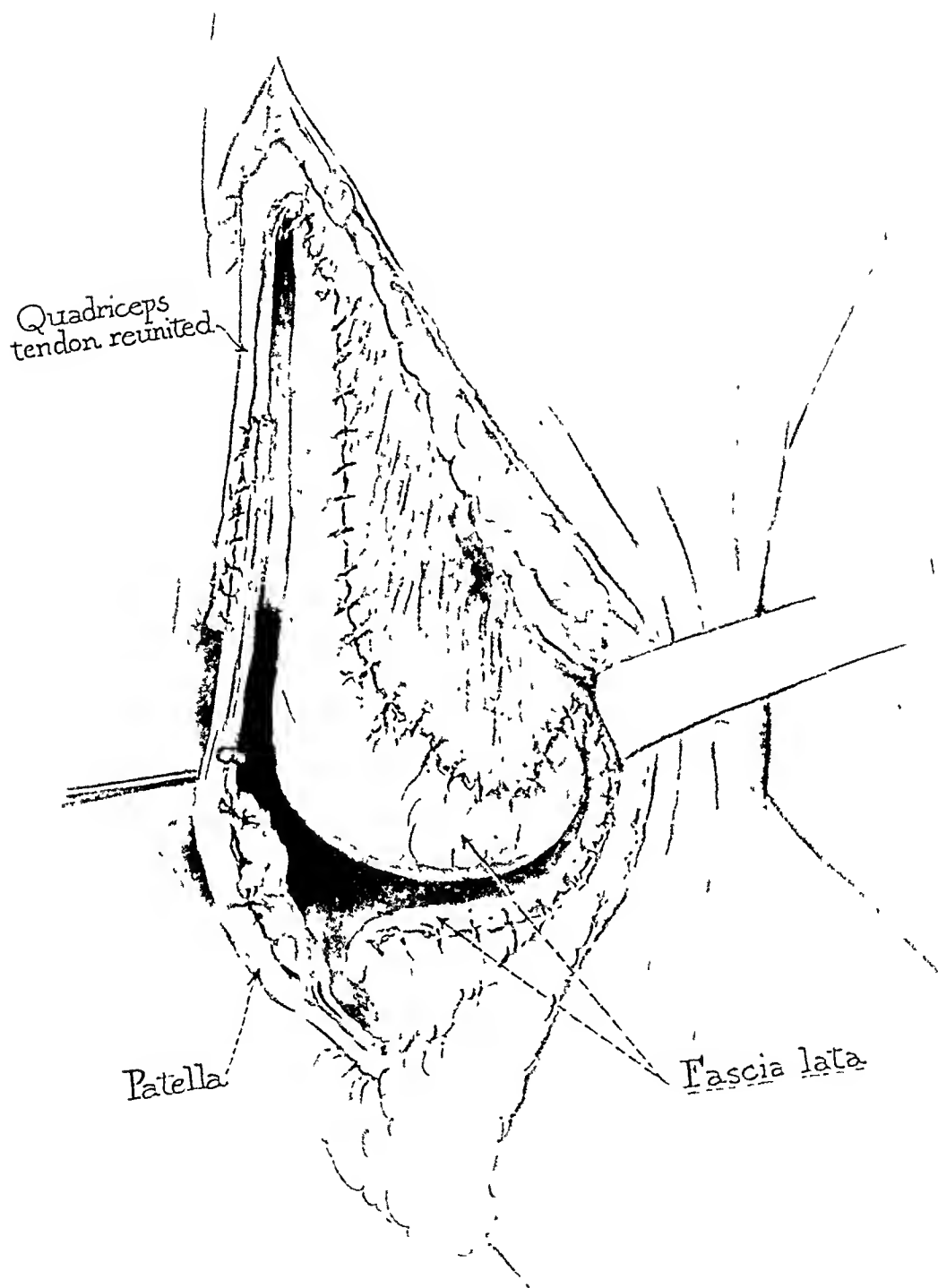


FIG. 14.—Side view showing area of attachment of fascia lata, and pedunculated flap covering patella.

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physiotherapy long-continued. Gentle brisement forcé three times. Ankylosis recurred in position of complete extension.

CASE XII.—Miss O. E., age sixteen, acute infectious arthritis, complete bony ankylosis, duration one year, position extension, routine procedure August 2, 1922. Free fascial transplant from opposite knee, result 40 degrees flexion, full extension, range of motion increasing.

As results cannot be stated in Cases XIII, XIV, XV and XVI, no history is given at this time.

FRACTURES ABOUT THE UPPER END OF THE HUMERUS

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THIS paper analyzes seventy-five fractures of the upper end of the humerus admitted to the Second Surgical Division at Bellevue Hospital, since 1916, or observed and treated by the writer outside of the hospital. They are consecutive cases and most of them have been observed for a sufficient length of time, so that it seems fair to make deductions as to the efficiency of the treatment adopted and as to the disability resulting from fractures in this location. This study has been limited to fractures of head, neck and adjacent portion of shaft (one and one-half inches below the lesser tuberosity), because the disabilities in abduction and rotation resulting from fractures in this region seem to be due to certain pathological factors which may bear emphasis and which differ from the factors concerned in fractures lower in the shaft.

The individuals in this series show an average age of 50.4 years. Eighteen were over sixty years of age, seven over seventy, one was over eighty. Thirty of the patients were women. On careful analysis of the histories, all these fractures were caused by direct violence with the possible exception of three cases—one a long comminuted fracture obliquely downward from the surgical neck, from a fall on the palm of the hand; one a spiral fracture from surgical neck through upper third of the humerus, from a fall on the elbow; one a fracture of the anatomical neck with dislocation of the head out through the capsule, from a fall on the extended arm. All these exceptions are, I think, susceptible to question as to the indirectness of the causative violence.

Twenty-one of these cases were admitted to the hospital two days or more after injury; sixteen were seen three days or more after injury. Eight, nine, eleven and forty-two days represent the limits in time before positive diagnosis was made. In fairness and honor to the profession, however, it should be stated that practically all of these cases had received medical advice which recognized the serious nature of the injury but due to exigencies of family life or natural procrastination, they had failed to report earlier for treatment.

Thirteen of these cases have had associated injuries at the time of admission, in some this associated injury representing the major surgical condition. These injuries were fractures of femur, four; fracture of adjacent clavicle, two; acromioclavicular dislocation, one; fracture of olecranon on same side, two—one with no separation, one with well-marked separation; Colles' frac-

ture same side, one; fractured ribs same side, two; dislocated meniscus, one. General contusions and abrasions have naturally been frequent and considering the average age of these patients not without significance.

In analysis these fractures have been grouped not only on anatomical lines, but also on the basis of pathological displacement which, according to its degree, renders easy or difficult the subsequent treatment. Grouping on purely anatomical lines is, I find, more difficult than it first appears for many of these shoulder injuries when first rayed on a flat plate in two planes will



FIG 1a — Dislocation of the head of the humerus, with fracture of the greater tuberosity. Condition on admission, July 3, 1923.

appear to fall into one group, whereas later check up with muscles relaxed and the patient in comfort will bring out lines of fracture which make them fall definitely into a different group. On such a basis, subject as it is to elements of error, these fractures for purposes of discussion are grouped as follows:

1. Anatomical neck, 4; (a) simple, 3; (b) with dislocation, 1.

2. Greater tuberosity, 5; (a) simple, 4; (b) with dislocation, 1.

3. Lesser tuberosity, 2; (a) simple, 0; (b) with dislocation (posterior), 2.

4. Surgical neck, 64; (a) simple with slight or

no displacement, 13; (b) simple with gross displacement, 31; (c) complicated—combining gross displacement of neck with greater tuberosity displacement, 17; (d) with dislocation, 3.

In the above groups, fractures of the anatomical neck have been rare. The patients in whom it was diagnosed were aged fifty-three, seventeen, seventy and fifty. The first case presented a picture of comminution of the head and this was excised through the surgical neck. The last case showed the head dislocated anteriorly through the capsule and this was excised along with the upper end of the shaft. The operative indications appeared clear,

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the results, however, were poor. Cases II and III were treated by suspension, abduction and rotation. The results were ultimately good.

Isolated fracture of the greater tuberosity occurred five times. In no case was indirect violence given as a cause. In one case (Fig. 1a and b) an accompanying anterior dislocation was present. In two other cases a history of reduction of a dislocation previous to admission was given. That this is open to question is obvious, although it is interesting to note in view of the statement in practically all text-books on fractures that such a fracture may accompany anterior dislocations. The displacement in the five cases noted was not marked, and in no case was it comparable to the displacement of this fragment when accompanied by fracture through the neck. The disability in these cases, however, was very marked, and seems to place this fracture in a class with fractures of the scaphoid in the great disproportion between the size of the fracture and the amount of disability.

This disability was present whether the fragment was large or small, and in the one case in this series, seen six weeks after injury, and in two cases outside of this series (observed under treatment in adduction and internal rotation), the disability in limitation of abduction, external rotation and loss of power persisted for months. This fracture should be recognized as a major injury in the disability it produces and due treatment accorded it. It has become our custom to give it the same care in suspension, abduction and external rotation which we give the apparently more important injuries about the shoulder.

Fracture of the lesser tuberosity alone has been encountered in two cases. In each case the fracture accompanied a posterior or subspinous dislocation of the head of the humerus. Both cases were admitted to our division since October, 1923, and are apparently the only cases seen in Bellevue in several



FIG. 1b.—Skiagraph of FIG. 1a, taken August 1, 1923, four weeks after injury.

years. The mechanism of production of this injury affords an opportunity for interesting conjecture, but it is unfortunate that in both the cases here mentioned history was indefinite and undependable. One was alcoholic and admitted six days after injury; one was psychopathic and admitted eight to twelve days after injury. In each case the fractured lesser tuberosity was displaced well down alongside the rim of the glenoid cavity and remained in this position of displacement after reduction of the head. In one case open operation was necessary for reduction of the dislocation; in the second case

a closed reduction was successful. These two cases will be the subject of an independent report.

The remaining sixty-four fractures of this series involved the surgical neck of the humerus. Thirteen showed slight or no displacement. In this group are placed all those fractures usually diagnosed as impacted fractures of the neck of the humerus. If by this term we mean a simple interlacing of small cancellous irregularities on the fractured surfaces which tends to minimize abnormal mobility, I heartily agree with this term. I would equally disagree, however, with any interpretation of this term in connection with the neck of the humerus



FIG. 2a.—Low fracture of the surgical neck of the humerus with median displacement of shaft. Condition on admission. October 11, 1922.

which conveys the idea of a "jamming together" with true shortening or which conveys the idea that manipulation may not easily displace these fragments. A careful study of these cases bears me out in this, and I think we should consider impacted fracture of the neck of the humerus as rare. Fracture with slight or no displacement would be a better term.

Thirty-one fractures of the surgical neck showed gross displacement with a single line of fracture. (Figs. 2 and 3, a and b.) Seventeen additional cases combined more or less comminution with fracture of the greater tuberosity as well. All showed gross displacement. The level of fracture in these cases ranged from old epiphyseal line to the insertions of pectoralis major and latissimus

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simus dorsi. The displacement accompanying these severe fractures of the surgical neck so often follows a definite type that it would seem fair to class as typical of this group of fractures the following position of the fragments—abduction and external rotation of the upper fragment with inward and upward displacement of the lower fragment. Frequently this latter displacement is of such degree that the upper end of the shaft is in a subglenoid or subcoracoid position. In this series such typical displacement varying, of course, in degree, has been present in forty-two of these forty-eight cases. This displacement is due

apparently to two factors: First, the lateral displacement due to the continued action of the fracturing violence; second, the longitudinal and rotatory displacement due to muscle action on the two fragments. The presence of this displacement must be considered of importance in the treatment of the fracture and the difficulties it presents in such treatment will be emphasized under such heading.

Three cases combined fracture of the surgical neck with gross displacement and dislocation of the head. One in 1917 was resected early; no records are available after his discharge from the hospital. One showed an anterior, partially subglenoid, position of the head with fracture through the neck and through the greater tuberosity, the latter displaced upward and outward. This fracture was treated by abduction and external rotation. At the end of two months open operation for reduction of the dislocation was done. Reduction was easy, but it could not be maintained as capsule and subscapularis offered no opportunity for good suture. His result was practically entire loss of shoulder joint action and almost all motion scapular. The third case was a partial subglenoid dislocation accompanying fracture through the surgical neck. She was admitted promptly after injury, placed in frame for her fracture, but the



FIG. 2b —Low fracture of the surgical neck of the humerus with median displacement of the shaft. Condition on November 8, 1922, five weeks after injury.

partial dislocation was overlooked. She had a poor result and well emphasizes the necessity for continuous close supervision over all these cases.

Treatment.—The early cases of this series have been through practically every recognized type of treatment for this injury. Although Case I followed very shortly the publication of Doctor Blake's article in the Archives de Medicine et de Pharmacologie Militaire in Paris, in 1916, and was treated by suspension, abduction and external rotation, traction was not made in sufficient degree to overcome the subglenoid position of the upper end of the



FIG. 3a —Fracture of the surgical neck of the humerus, complicated by long spiral fracture of the upper shaft of the same bone. Condition when admitted, March 20, 1923

shaft, and after three weeks he was subjected to anæsthesia and traction on the Hawley table with plaster spica. Only angulation at the site of fracture resulted. After forty-eight hours, abduction to 45 degrees, suspension and traction were again used—too late, however, for good anatomical alignment. His result, however, as to function was good; at the end of five months abduction was perfect, external rotation good, internal rotation poor in that he could not reach his back. Following this case, the shoulder cap with weight extension, plaster spicas, Middledorpf triangle, aeroplane splints were all used, mainly, however, after suspension, traction

abduction for the first ten to seventeen days. That this haste to ambulate many of these cases in fixed adduction defeated the advantages of the initial treatment is obvious. In the last fifty cases of this series where any mechanical treatment at all was thought advisable, only suspension, abduction, traction and external rotation have been used, the various elements in this combination varying according to indications. The advantages of this method of treatment were so clearly and ably demonstrated by Dr. Kenneth Bulkley and Dr. James N. Worcester on our division that its use has now become practically routine with us. The technic and details of application of this treatment have become so familiar to those interested in major fractures, and so much has been published

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illustrating the overhead frame for suspension and the various points for obtaining traction in fair anatomical alignment that further discussion on these details seem superfluous. Certain conclusions as to applicability, however, may well drawn and emphasis on certain details may well be justified.

There is one optimum position in which practically all fractures about the neck of the humerus should complete their union and this position is one of *wide abduction and external rotation*. This conclusion is based not only upon a consideration of the bone displacement which attends the great majority of these fractures, but also with greater emphasis upon a consideration of the injury to capsule, muscle and muscle attachments which must accompany every such fracture. Anatomically the shoulder joint sacrifices a certain amount of security to obtain its marked physiological range of motion. A redundancy of capsule at the inferior portion is necessary to permit of wide abduction. This redundancy in the abducted position is probably the source of a certain amount of post-traumatic intracapsular adhesion. The capsule is attached on the antero-inferior aspect not only along the anatomical and surgical necks merge, but also somewhat down the shaft. The subscapularis flattens over this capsule in front and sends some fibres of insertion into it before proceeding to its main one and one-half inch insertion into lesser tuberosity and just below. Above and posteriorly, supra- and infraspinatus and teres minor send fibres to the greater width of the neck and from the greater tuberosity downward over the soft structures about the neck and neck. Add to this visualization of the soft structures about the neck and tuberosities a direct violence to this region implicating the deltoid and sufficient to cause fracture in a patient over fifty years of age, and we have present all the elements requisite for a prolonged disability. It is our function to shorten this disability in so far as we may and if possible to relieve it entirely.



FIG. 3b — Condition April 15, 1923.

This disability manifests itself as a rule in three directions—limitation in abduction and rotation and loss of power. The severity of the disability is frequently out of all proportion to the apparent severity of the fracture as in the isolated fractures of the greater tuberosity. Recognizing all these fractures as potential sources of serious disability, treatment should aim toward good functional results in as short a period as possible. We feel that suspension and traction with abduction and rotation do this. The attendant hospi-

talization for approximately one month seems to be time well spent. In this series it has been free from any untoward complications. It is a type of treatment that tends to maintain fair circulation in the fractured limb, promotes early and fair alignment of the fractured fragments, and what seems most important of all, takes into maximum consideration the associated injuries of the soft parts and places such parts in a position in which recovery is hastened.



FIG. 4.—Fracture dislocation. Late operation for reduction of dislocation unsuccessful.

The practical use of this method as a routine, however, shows a large number of fractures of the neck of the humerus in whom immediate abduction to 90 degrees is contra-indicated in that angulation will occur at the site of fracture. Such angulation may result in some of the fractures with slight or almost no displacement; it is almost sure to result in those types where the upper end of the shaft is grossly displaced internally. Muscle spasm in pectoralis major particularly, possibly in latissimus and teres major, probably plays the major rôle in this angulation. Although wide abduction and external rotation is the desirable position for this group to convalesce in, its attainment must be postponed for the first few days. Usually traction in the slightly abducted position for a few days will be necessary with perhaps a little lateral traction on the shaft of the humerus. As muscle spasm is overcome and fractured surfaces become sufficiently adherent, it is then possible to gradually increase abduction to the optimum position, reaching 90 degrees abduction by the end of seven to ten days. A delay in the recognition of this principle in a number of our cases led to their convalescence in the moderately abducted position. This apparently delayed the recovery of function in some of these cases.

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Arbitrarily we have accepted about four weeks as the time limit for fractures about the neck of the humerus to remain in suspension. They are then allowed up and encouraged to begin immediate active exercise of the shoulder joint by facing the wall, and with fingers flat against it, crawling up the wall after the manner of a measuring worm. As maximum elevation is reached, the body is turned so that the arm is externally rotated as well as abducted. While this combines a certain amount of passive with active motion, the extent of movement at first is never beyond the point at which the patient has been suspended previously. In

fact, as a rule, this point of previous suspension is the mark toward which he aims for several days. Light massage and physiotherapy are not overlooked, but in the minds of many patients they are accorded undue importance and are considered the end instead of the means to the end. Coöperation and real work on the part of the patient are absolute essentials to a steady progressive increase in function and strength. Lacking these essentials the patient may undo in a short time the work of several weeks



FIG. 5.—Fracture dislocation. Operation. Final result. All motion scapular.

by adopting a policy of inaction and immobilization in a sling or bandage.

Results.—Any tabulation of results in a series of fractures about the shoulder where joint action itself is so well coördinated with scapular and sternoclavicular action necessarily involves the personal equation so much that such tabulation becomes valueless unless some arbitrary standard of comparison is adopted on which to base judgment. I know of no well-worked out physiological scale for such comparison. Even abduction which the majority will consider most easy of measurement will vary under different observers from 10 degrees to almost 90 degrees. One observer will measure simply with his eye, another may take pains to measure with the angle of the scapula firmly grasped between the fingers. External and internal rotation are similarly difficult or even more difficult to check up. Good function in external rotation may be at the expense of some function in internal rotation.

However subject as they are to a large percentage of error in interpretation as well as to a certain degree of variation in the individual patient, the results in this series have been measured by the following scale:

Abduction—measured in degrees with digital fixation of angle of scapula.

External rotation in abducted position with forearm flexed—good if latter moves up to or beyond the plane of the body.

External rotation in adducted position with forearm flexed—good if 20 degrees or more beyond the sagittal plane.

Internal rotation in abducted position with forearm flexed—good if 45 degrees or more below the horizontal.

Such a basis roughly makes good external rotation reach to the back of the head and good internal rotation reach to the sacroiliac region of the same side.

Of the five isolated fractures of the greater tuberosity, four treated in hospital were discharged within from three and one-half to five weeks with 75 degrees or more abduction, good external rotation but poor internal rotation. In two followed up, four months and two

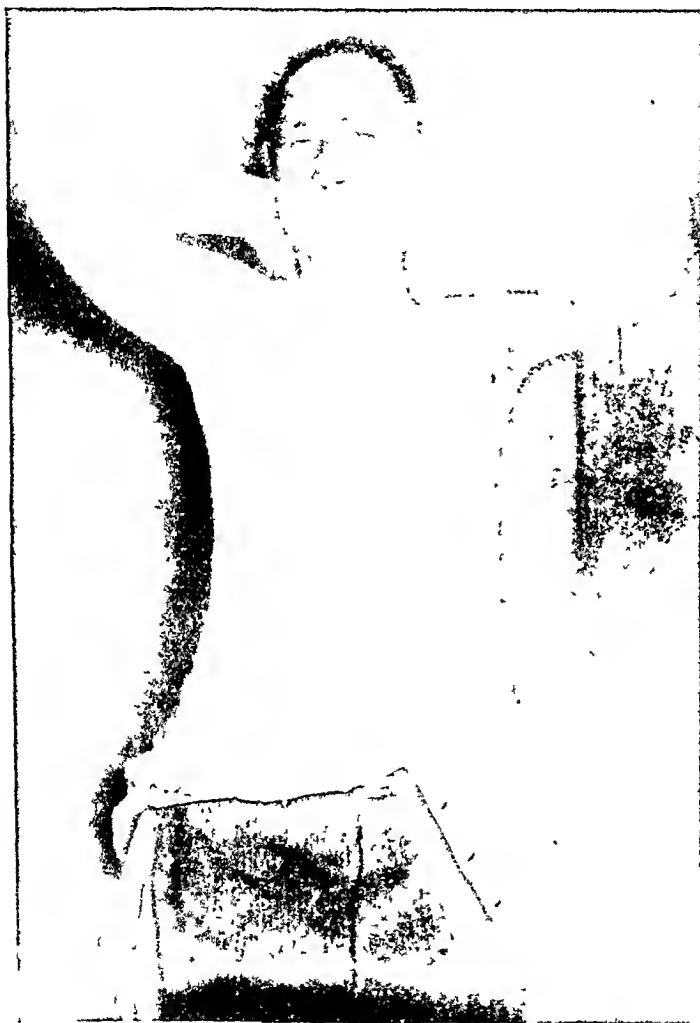


FIG. 6—Fracture dislocation. Operation. Final result. All motion scapular.

months longer were necessary for internal rotation to become good; abduction at this time was 90 degrees. The one case seen six weeks after injury continued a disability for over ten months.

Of the fractures of the surgical neck with little or no displacement, six were followed to the final result. One (age thirteen) treated initially in Sayre strapping showed excellent function in three months; one (age seventy-one) treated simply by abduction and external rotation on pillows showed excellent function, except for strength, in four weeks. Three cases suspended

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in apparatus showed good function in eight weeks (age thirty-six), nine weeks (age seventeen), three months (age fifty). One (age seventy) showed good function on discharge in thirty-five days, only fair function after four months, abducted only 45 degrees with soft joint crepitation after one year. Rotation, however, was good.

The fractures of the surgical neck with gross displacement were all treated in suspension. The final notes in nineteen cases follow:

Age	Time of note	Abduction	Rotation		Remarks
			External	Internal	
1. 42	5 Months	90 Degrees	Fair	Fair	Poor anatomical result
	9 Months	90 Degrees	Good	Good	
2. 40	2 Months	50 Degrees	Fair	Fair	
3. 70	6 Weeks	85 Degrees	Poor	Poor	Bad comminution
	10 Months	70 Degrees	Poor	Poor	
	3 Years	30 Degrees	Almost none		
4. 40	4 Months	90 Degrees	Good	Good	Waitress
5. 50	2 Months	90 Degrees	Good	Good	Strength—(minus)
6. 50	6 Months	90 Degrees	Good	Good	
7. 58	6 Months	90 Degrees	Good	Good	
8. 60	8 Months	90 Degrees	Good	Good	
9. 39	2 Months	90 Degrees	Good	Good	
10. 58	6 Weeks	90 Degrees	Good	Good	Strength—(minus)
11. 41	5 Months	80 Degrees	Good	Good	
12. 49	2 Months	90 Degrees	Good	Good	
13. 54	3 Months	90 Degrees	Good	Good	
14. 44	3 Months	90 Degrees	Good	Good	Strength—working
15. 57	4 Months	90 Degrees	Good	Good	Strength—working
16. 49	5 Months	90 Degrees	Good	Good	
17. 32	9 Weeks	90 Degrees	Good	Good	Working
18. 70	3 Months	75 Degrees	Good	Fair	
19. 54	3 Months	All motion	scapular		Dislocation—Operation refused

Of these nineteen cases, fifteen had good functioning shoulders within two to nine months, thirteen of these within five months. Two had only fair function at the end of two and three months, respectively, when their last notes were made. Two were distinct failures as to function, one a badly comminuted fracture of head and greater tuberosity, one an unreduced partial dislocation in whom fracture healed well anatomically.

Six cases in this series were operated on. No case was subject to operation except on indications which seemed to permit of no other procedure. Such indications were (a) complicating dislocations not reducible, (b) gross displacements or comminution of head where no apparent contact between fractured surfaces could be established. The operations done included two excisions of the head through the surgical neck, one simple removal of head dislocated through capsule, one open reduction of a posterior dislocation in which lesser tuberosity was fractured, one instrumental manipulation of a rotated head and greater tuberosity to establish alignment, one late reduction

of subglenoid dislocation after union of fracture with unsuccessful plastic on capsule. The operations were all done rather late after all other means had failed. Perhaps this was an error in judgment. The results have been uniformly discouraging. (Fig. 5.) Of five followed, four have practically no joint action. One excision at the end of three months had normal passive motion, very little active. He looked encouraging but has not been seen since. In fact, the end results in these cases have been little different from analogous types of cases in whom no operation was done.

SUMMARY

In conclusion certain broad, general deductions based upon the above series may be permitted me.

Fractures about the neck of the humerus occur mostly beyond mid life. The resulting disability is usually marked and prolonged. It is done mainly to the associated injury of soft tissues about the site of fracture. Wide abduction and external rotation is the position of choice for convalescence. Such position in a number of cases must be attained gradually. While recognizing the value of various types of ambulatory splints, I feel that the conditions



FIG. 7.—Fracture dislocation. Operation Final result. All motion scapular.

here encountered are best and most comfortably met by bed and traction suspension treatment with a frame. Massage and physiotherapy are aids in treatment, but the best and quickest results reward the coöperative, intelligently active patient. For this reason women who resume their household duties early seem to regain function and strength more rapidly than men.

I wish to express to Dr. John A. Hartwell, Director of the Second Surgical Division, my appreciation of the privilege of reporting the above cases and also my appreciation to the changing but ever conscientious members of the House Staff who do so much of the work in such a series.

IDIOPATHIC OSTEOPSATHYROSIS^{*}

(FRAGILITAS OSSIUM)

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IDIOPATHIC osteopsathyrosis is a definite and distinct disease entity. Its differentiation from other bone diseases may be made with certainty from the history alone. In no other disease are there numerous and repeated fractures resulting from insignificant trauma and occurring throughout entire life of individual.

In osteopsathyrosis the long bones are most frequently the site of the predominating feature—fracture. The linear development of the bony skeleton is usually normal, but the height of the individual is shortened by the bowing and angulation of the long bones, incident to their repeated fracture and faulty union. The epiphyses are not enlarged; the diaphyses are originally straight and cylindrical but soon become bowed and flattened, most frequently in the antero-posterior diameter.

Bone fragility, in this disease, is not due to an insufficiency of the inorganic chemical constituents, since on analysis of psathyrotic bone these constituents are found to be quantitatively normal.

It is to morphological defects in the bony framework, producing mechanical instability, that the characteristics of osteopsathyrosis must be ascribed. These defects consist of a thinned porous cortex, the continuity of which is often interrupted, and the presence, within the medullary cavity, of isolated areas of new bone. The absence of fibrous tissue renders these bones inelastic. Their strength is impaired by the loss of their normal tubular structure.



FIG. 1.—Idiopathic osteopsathyrosis (fragilitas ossium) from the orthopaedic wards of the Philadelphia General Hospital. W. J., age thirty-eight.

^{*} Read before the Philadelphia Academy of Surgery, February 4, 1924.

Etiologically, osteopsathyrosis is independent of any luetic or other infectious origin. Locke⁵ believes with Harbitz²⁸ that during foetal life there is some nutritional disturbance which affects the entire bony system. Voorhoeve³⁰ attributes the development of this disease to a hereditary inferiority of the mesenchyme. The possibility of an endocrine disturbance as a primary cause cannot, as yet, be discarded.

Extensive research by many workers has proven that a familial predis-



FIG 2—Röntgenogram of skull showing distortion of the cranial outline, diffuse areas of rarefaction, indistinct suture lines, extremely small sella turcica, undemonstrable clinoids and large sphenoidal sinuses

position to osteopsathyrosis (IV) exists. The frequent coëxistence of blue scleræ (V) and impaired hearing with this disease has been established. Blegvad and Haxthausen³² believe the blue scleræ to be a dominant characteristic under the Law of Mendel. Gurlt³⁴ considers that the tendency to fracture is transmitted to males through unaffected females; more recent work does not bear out this opinion.

W. J. was admitted to the service of Dr. J. T. Rugh on the first of September, 1923. He was suffering from an acute fracture of the middle third of the left femur with marked displacement of both fragments.

From earliest childhood the patient has been subject, on the slightest trauma, to fracture of the long bones. The left tibia and fibula have been fractured twelve times;

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the right, six; the left femur, six; its fellow, five. The left ulna and radius have been fractured nine times, the right, seven. The ribs, metacarpals and metatarsals have been fractured on numerous occasions. There is no history of fracture of the skull nor of either humerus.

There is no history of previous illness other than measles and an occasional "cold."

The patient's father died of "kidney trouble"; a sister, at the age of twenty, of pneumonia; a brother, of typhoid fever at twenty-four. The mother is living and well; there are no other children; there is no history of miscarriages or stillbirths. In no member of the immediate or remote family is there any history of bone disease or blue scleræ.

The patient has never been married, has always been of good habits, and has lived his entire life at home.

The patient is a grotesque, dwarfed, and misshapen negro (Fig. 1), thirty-eight years of age. He is fifty-two inches tall and weighs seventy pounds.

The head is fringed with black kinky hair interspersed with white. The occipital and temporal protuberances are prominent, while the forehead is high. The occipito-mental diameter is 21.0 cm., while the occipitofrontal is 19.2 cm., the bitemporal 16.0 cm., and the cranial circumference is 55.0 cm. The occipital prominence protrudes abruptly 1.9 cm. beyond a normal contour (Fig. 2).

The ears are free from gross abnormalities, but the hearing is impaired.

The eyes are prominent and protrude 3 mm. beyond normal without increase of intra-ocular pressure. There is complete bilateral arcus senilis with beginning opacity of the periphery of both lenses. Sight is decreased to O.D. 6/25, O.S. 6/25. The pupils are equal and regular and react promptly to light and accommodation. The eye grounds are normal. There are neither extraocular palsies nor nystagmoid movements. The scleræ have a pronounced and evenly distributed bluish color.

Lips, tongue, and mucous membranes of the mouth present no abnormalities; the teeth are firm and even.

The neck is free from adenopathy, while the thyroid is barely palpable.

The chest is funnel-shaped, with a suggestion of a rachitic rosary. The cylindrical thoracic cage tapers abruptly to its junction with the abdomen. The heart and lungs are normal. The systolic blood-pressure averages 100; the diastolic, 58. The pulse ranges between 100 and 120.

The abdomen is small, muscular, and rotund, and terminates in a tilted, flattened,



FIG. 3.—Röntgenogram of femora showing recent fracture of the left femur with displacement of the fragments. The thin, shell-like cortex and rarefied diaphyses characteristic of osteopsathyrosis are apparent in this plate.

pelvis. A marked left dorsal scoliosis and a pronounced lumbar lordosis distort the spinal column. The genitalia are underdeveloped.

There is bowing of both humeri and posterior luxation of both ulnæ. The femora are bowed laterally and the left is the site of a recent fracture in its middle third (Fig. 3). The right leg is comparatively straight. The left tibia and fibula are angulated laterally to ninety degrees in their middle third, so that the long axis of the foot is parallel to the normal axis of the leg (Fig. 4). The hands and feet are twisted and gnarled and



FIG. 4.—Röntgenogram of legs showing acute angulation of the left tibia and fibula. The left tibia and fibula are fused in their middle third at the site of repeated fracture and marked rarefaction. The right tibia and fibula are joined by a bony bridge. The fibula has been fractured at the point of contact and is extremely thin. Arrow marks the site of amputation.

Believing that it would be to the betterment of the patient if the useless left leg and foot were replaced by an artificial limb, the leg was amputated 6 cm. below the knee-joint. The operation was performed by Dr. J. T. Rugh under ether anaesthesia. Cross-sections of the tibial shaft were selected for chemical and histological examination from a point not previously the site of fracture. Cultures were immediately made of the bone, the marrow cavity, and the surrounding tissues. These cultures proved to be free from bacterial growth.

The cross-section of the tibial shaft submitted for chemical analysis weighed 9.46 gm. and contained 76 per cent. of dry matter, of which 38 per cent. was ash. The averages of two analyses of the ash gave 18.205 per cent. phosphorus; 38.39 per cent. calcium and 0.615 per cent. magnesium. These analyses were made by Mr. Herman L. Hinski of the Biochemical Laboratory of The Wistar Institute of Anatomy and Biology.

Grossly, the fresh specimen of psathyrotic bone was spongy in appearance, the peri-

have large callosities over their proximal phalangeal joints. The rotary movements of the forearms and the finer movements of the hands are impaired.

The urine is acid, with a specific gravity of 1023, and is without casts, albumen, or sugar; it is also free from acetone, indican, and Bence-Jones protein.

The blood shows a hæmoglobin of 95 per cent.; the erythrocytes number 5,650,000; the leucocytes, 11,600, of which 62 per cent. are polymorphonuclears, 36 per cent. small lymphocytes, and 1 per cent. each are eosinophiles and basophiles. It contains, per hundred cubic centimetres, 80 mg. of sugar, 12 mg. of urea nitrogen, and 3.6 mg. of uric acid, while the blood plasma contains 10.9 mg. of calcium and 3.2 mg. of phosphorus.

The blood Wassermann is negative in both the cholesterolin and Noguchi antigens.

On admission, the basal metabolism showed a rate of plus 46, but after two months' enforced rest, it fell to plus 23.

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osteum ragged, the cortex thin and friable, the marrow soft, œdematous, and mushy. The histological examination showed that the periosteum was slightly thickened, but in general presented a normal structural appearance. Its outer layer was densely fibrous, its inner portion somewhat more cellular and vascular. The intimal coats of a few small arteries were thickened. The osteogenetic layer was inconspicuous and appeared unproductive.

The cortex did not form a continuous ring, but was broken into large and small segments. These showed marked distortion of the Haversian canals and concentric lamellæ. Thus many canals were extraordinarily large and appeared to be filled with a narrow substance. On the contrary, other canals were small, narrow, and apparently compressed. The vessel walls were frequently thickened and partly hyalinized. The bone corpuscles were often small, shrivelled and numerically decreased.

The bulk of the section, as shown by the photomicrographs (Figs. 6 and 7), was composed of loosely arranged bony trabeculae which simulated spongy bone and branched throughout the medullary cavity. These trabeculae intermingled with the islands of compact bone. Between them were irregular marrow spaces occupied by a delicate stroma which contained eosin-staining structureless substances (œdematous material), fat cells, moderate numbers of round cells and many small blood-vessels. These vessels were, for the most part, capillaries, but here and there arteries with thickened intimal coats could be seen. There were no inflammatory cells of any type present. There was no conspicuous overgrowth of connective tissue. Closely approximating the islands of

compact bone were small groups of multicellular osteoclasts. Rows of flattened diminutive osteoblasts clothed the majority of the osseous trabeculae. Only a small number of the osteoblasts presented their typical cuboidal form.

The pathological process, therefore, seems to be of a twofold nature; first and most important, an active bone resorption, associated, secondarily, with a new bone formation throughout the marrow cavity.

A röntgenological examination visualizes the salient structural features of osteopsathyrosis. The thinned cortex, the bowing and angulation, the widely disseminated porosity, and the evidence of the remarkable reparative properties of psathyrotic bone are here shown. It is with difficulty that the site of single fractures can later be demonstrated by röntgenograms. Only after several fractures have occurred in the same locality is the normal contour of the bone markedly altered.



FIG. 5.—Cross-section of tibial shaft for microscopic study. In this low-power photomicrograph are discernible the thin, broken cortex, the distended Haversian canals, the trabeculae of new bone in the medullary cavity as described above. (Photomicrograph.)

An analysis of the above case discloses several facts which are of interest in their bearing upon the general phases of osteopsathyrosis, upon the theoretical etiology of the condition and upon the relation of this case to those cases which have been reported in the literature in the past two hundred years.

It is of note that W. J. has been subjected to repeated fractures throughout his life, from earliest childhood to advanced maturity, and there is the strong possibility that his distorted cranium may be due, at least in part, to intra-uterine fracture. There is no evidence that the frequency of fracture is growing less as age advances.

The fact that neither the history, the clinical findings nor the serological tests reveals a luetic taint is of interest in that so many of the reported cases,



FIG. 6.—Detail of Fig. 5 in higher power. (Photomicrograph.)

purporting to belong to the group of osteopsathyrosis, are either definitely syphilitic, or lues, as a complication, has not been eliminated.

The normal calcium and phosphorus content of the blood plasma and the normal calcium, phosphorus, and magnesium content of the bone disprove, in this case, the theory that a deficiency of these elements is the cause of osteopsathyrosis.

The absence of any type of inflammatory cell in the histological sections, the sterile cultures of the bone and its surrounding tissues, together with the normal temperature curve,

are strong evidences, if not actual proof, against the theory of infection.

That there is an increased resorption of bone in osteopsathyrosis and that the normal tubular structure of the diaphyses is destroyed are shown by the microscopic study. And that these may be due, in this case, to a primary disturbance of the endocrine glands is suggested by the high basal metabolism, the pronounced exophthalmus, the palpable thyroid, the mild tachycardia, the underdeveloped genitalia and the shallow pituitary fossa.

In addition to these salient facts the age of this patient is of interest in that few cases reported in the literature have lived as long. It is also interesting to note in this case that there is no history of bone disease or blue sclerae in any other member of the family. Finally, it may be mentioned that despite his frequent fractures, this patient was at all times remarkably free from pain.

IDIOPATHIC OSTEOPSATHYROSIS

SUMMARY

1. A case of idiopathic osteopsathyrosis (fragilitas ossium) occurring in a negro thirty-eight years of age is here reported.

2. The patient has suffered, as the result of slight trauma, approximately forty-five fractures of the long bones.

3. The calcium and phosphorus content of the blood plasma and the calcium, phosphorus and magnesium content of the bone are normal. The basal metabolic rate is increased; there are marked exophthalmus, palpable thyroid, immature genitalia, shallow pituitary fossa, mild tachycardia, blue scleræ and impaired hearing.

4. No history of syphilis, infection or familial predisposition to bony fracture or disease can be elicited. There is no history of blue scleræ in the members of the immediate or remote family.

5. Microscopic examination of the cross-section of the tibial shaft procured by amputation of the left leg shows a broken and thinned cortex, distended Haversian canals, increased bone resorption and new bone formation.

6. Photographs of the patient, röntgenographs of the bony skeleton and photomicrographs of the bone sections are embodied in the paper.

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SYSTEMIC BLASTOMYCOSIS (OIDIOMYCOSIS)

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IN 1894, Gilchrist¹ described before the American Dermatological Society, a yeast-like organism which he found in a section taken from a patient with an unusual dermatitis. He classified the organisms as blastomycetes and named the disease blastomycetic dermatitis. A few months later, Busse² described a fatal case and demonstrated the pathogenicity by finding the organism in the internal organs as well as in the skin. He termed the disease saccharomycosis hominis. The bacteriological and clinical features of these two cases are quite identical with those subsequently reported by various men as blastomycosis or oidiomycosis.

The following case is described as a fatal case of the systemic disease, and is unusual because of the small amount of pathology found in comparison to the symptoms.

Clinical History.—A. B. S., age twenty-seven, male, American. First admission March 28, 1922. Discharged May 26, 1922. Admitted again January 3, 1923. Died March 7, 1923.

There was nothing of interest in his family history. He denied luetic infection, but admitted gonorrhœa four years previously. For two years prior to admission he had been employed as a miner in an Illinois coal mine. The onset of his disease dated back to March, 1921, (a year before admission) when he mashed the fourth finger of his right hand. The resulting injury remained a granulating ulcer for 10 months. A few weeks after this injury he became aware of pain in his lumbar spine. Two months after onset of his lumbar pain, he noticed a fluctuating lump in his lumbar region, which was incised and had drained continuously up until admission. A few weeks after incision of this abscess there developed skin lesions, in order of appearance, on the back of his neck, over the right shoulder, on the left buttock and on the right leg.

November, 1921, patient developed a cough which gradually increased in severity, and which was productive of a blood-stained, muco-purulent, grayish-brown sputum. Associated with this he had a definite but slight shortness of breath, but scarcely any pain. About March 5, 1922, (three weeks prior to first admission) he developed a soft fluctuating mass over his right jaw. At about the same time his scrotum began to swell, and two weeks later a sinus developed on the right side. He had lost about 30 pounds of weight since the onset of his disease, and was bedridden at the time of admission.

Physical Examination.—The patient is a well developed, but moderately emaciated and anemic middle aged man. Over the occipital region, left scapular region, left posterior thorax and right buttock are skin lesions varying from 8 to 16 cm. in diameter (Fig. 1). Each lesion has a red irregular cauliflower-like surface, which bleeds readily. The base is reddened and elevated. The centre

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of some lesions show scarring of recent healing. Mild discharge, but no deep ulceration is present. Fresh lesions first show up as small papules or pustules which later coalesce to form the cauliflower-like mass.

Just to the left of the spine of the 5th lumbar vertebra is a mass of granulations (2 cm. in diameter) with a draining sinus in the centre. Within one to two cm. of the edges of the various lesions are tiny miliary abscesses, some of which can scarcely be seen with the naked eye (Fig. 2).

Over the ramus of the right jaw and adjacent tissue is a tense, smooth fluctuant



FIG. 1.—Appearance of skin lesions on neck and shoulder at time of first admission before treatment was started.

mass 5 x 8 x 10 cm. Pus is present and feels superficial. Only slight tenderness is present. On account of this abscess, he is not able to open his jaws more than 1 cm. Below the above mass is a nodular mass suggesting numerous small lymph glands matted together.

Respiratory excursion of the right side of the thorax is distinctly less than the left. Breath sounds are harsh over the right upper lung, where the percussion note is impaired. A few crepitant râles are heard here and at each base.

The liver is palpable 5 cm. below the costal margin and is very tender. The splenic dulness is increased.

There is a discharging sinus over the right epididymis which is 5 cm. in diameter, firm and tender.

A recently healed ulcer is noted on tip of the fourth finger of the right hand at the site of his initial lesion. Definite but slight tenderness is made out over the spines of the 3rd and 4th lumbar vertebrae.

Laboratory Data.—Erythrocytes, 4,600,000. Leucocytes, 12,000 to 25,000. Haemoglobin, 80 per cent. Differential count: Polymorphonuclear neutrophils 60 per cent. Lymphocytes, 35 per cent. Large mononuclears, 3 per cent. Eosinophiles, 2 per cent.

Phenolsulphonephthalein kidney test 75 per cent. in 2 hours. Blood Wassermann

negative. Sputum:—Consistently negative for tubercle bacilli. Complement fixation for tuberculosis negative.

Urine: Faint trace of albumin. Few white blood cells, no red blood cells. Few granular casts.

Blood culture negative. Culture of aspirated pus from abscess of jaw, hemolytic streptococcus. Culture from miliary abscess of neck, blastomyces.*

Stool: Red blood cells found during attacks of diarrhoea. Benzidin consistently positive. Frequent yeast-like organisms, having a double contoured surface, which, however, could not be established definitely as blastomyces.

X-ray studies of the gastro-intestinal tract were made by Doctor Mills who



FIG. 2.—Skin lesion on buttock before institution of treatment.

reported an unusual gastritis, characterized by massive gastric roush.

Course During First Admission.—(March 28, 1922, to May 26, 1922). The patient's temperature persisted irregularly around 100°. Pulse 90 to 110. The abscess of the jaw, was incised shortly after admission, and thin greenish pus obtained. The abscess cavity healed very slowly. He was put on intensive potassium iodide treatment, and was able to tolerate 150 grains per day. One heavy dose of X-ray therapy was given over two of the lesions, but no difference could be seen in the rapidity of healing. Under iodide treatment, his lesions began to heal remarkably fast, and at the time of his discharge, the cauliflower-like granulations had been replaced by a scaly scar which seemed to progress from the centre outward. Over a period of a few days he complained of intense epigastric pain, but without any signs of peritonitis. He was confined to bed when admitted, but regained his strength rapidly and at the end of four weeks was walking around without discomfort.

Microscopical and Cultural Characteristic of the Organism.—Smears were made repeatedly from the various open skin lesions and the sinus over the back,

*Credit is due Miss Ludwig of the bacteriological laboratory of Barnes Hospital, for assistance with the cultures.

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but only occasionally, could one find unquestionable blastomyces. From the military abscesses, however, smears consistently yielded a moderate number of organisms and produced a pure culture of blastomyces.

On the third or fourth day of incubation tiny colonies of the yeast could be seen on the surface of the media. These colonies were heaped up, wrinkled, had irregular edges and were of a dark gray color. They grew equally well on blood agar and glucose agar, but seemed to produce a heavier and earlier growth on Russel's media than upon any of the others tried. In broth a granular cloudiness developed in five or six days and by the end of twelve days a grayish granular precipitate of the organisms was formed. As the culture on solid media aged, the color of the growth became darker. When the culture tube was sealed, thus restricting air, the organism invariably formed aerial hyphæ within three weeks, and in gross appearance greatly resembled a mould.

Microscopically, the organism was seen in tissue only in the budding form. Likewise, the minute colonies obtained by transplant directly from patient to media, consisted almost entirely of budding forms for the first few days. As the culture aged, however, mycelia appeared and became more predominant as successive transplants were made. It was also noted that unfavorable conditions during incubation, such as low temperature or dry media tended to produce more and thinner mycelia threads.

The organism in the budding stage is 8 to 18 μ in

diameter, is round or slightly oval, and is doubly contoured. No nucleus can be definitely identified, but the protoplasm is coarsely granular and contains highly refractile bodies. Occasionally, vacuoles are seen. The terminal or younger mycelial segments are more homogeneous and contain fewer granules. As the culture ages, there is an increasing tendency toward formation of terminal and lateral conidia which are connected to the main stem by short thick pedicles.

The organism produced no gas in either dextrose, lactose or saccharose broth.

Animal Experiments.—The organism proved consistently pathogenic to guinea pigs. Five were injected intraperitoneally, all of which died in about four weeks. Organisms were demonstrated either in culture or section in all but the first. A mouse which was injected intraperitoneally died in 24 hours, but no organisms could be found. One rabbit was injected intraperitoneally but showed no evidence of disease. In none of the guinea pigs were tuberculous lesions found.

Progress Since First Admission.—On January 3, 1923, seven months after discharge, he was admitted again. He volunteered the information that he had stopped the daily dose of iodide several times, for periods of 2 to 3 weeks, and

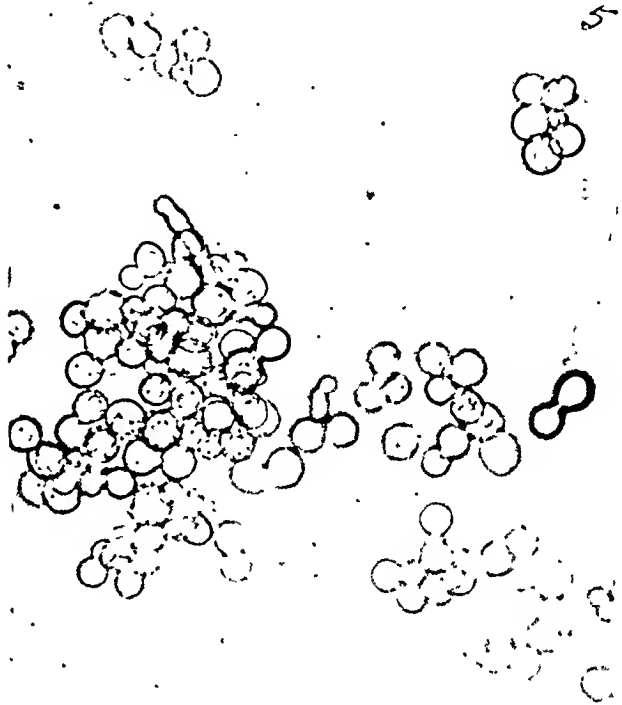


FIG. 3.—Culture four days after transplant from minute abscess to blood agar, showing predominance of budding forms.

had suffered from appearance of new lesions and general ill health. During the last four weeks previous to second admission, he had three convulsions of a generalized type. Two weeks before second entry, his scrotum and ankles began to swell. He had been gradually losing weight.

Examination showed the lesions to be dried but scaly as at discharge of first entry. Scattered over the body were several small fluctuant superficial abscesses, which contained thin greenish pus, in which blastomycetes could be found. The sinus of the epididymis had healed, but the sinus over the 4th lumbar vertebra was still draining. There was marked œdema of the ankles and scrotum, as well as

fluid in his peritoneal cavity. The lung findings remained practically the same.

In addition to heavy doses of potassium iodide by mouth, patient was given several intravenous doses of 50 to 75 grains of sodium iodide. He also received several doses of salvarsan. From none of these procedures did he receive any beneficial effects. He became very weak and died apparently from toxemia on March 7, 1923.

Organisms were again found in his sputum, but were not

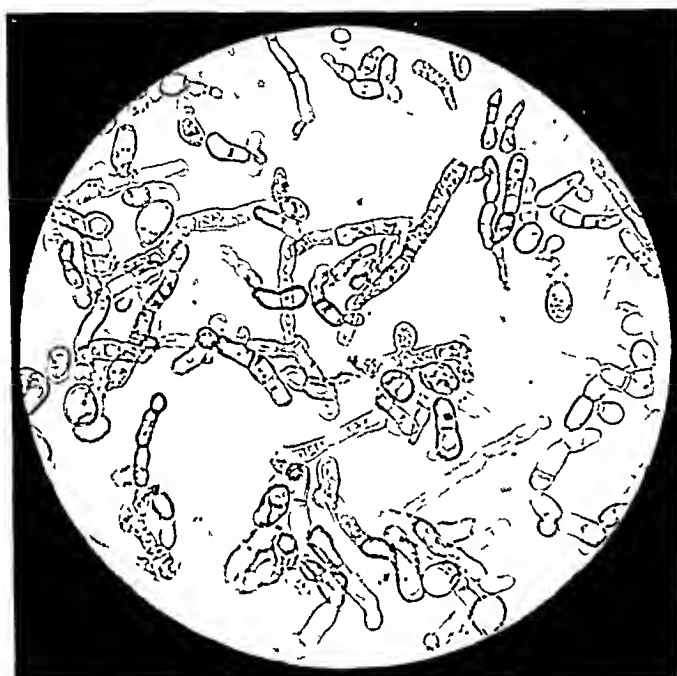


FIG. 4.—Appearance of culture after several transplants. Note predominance of mycelial forms. Occasional terminal and lateral conidia are seen.

demonstrated in the urine as they were on his first admission. His N.P.N. remained normal. Urine gave a very heavy test of albumin and contained many casts, a very few of which were waxy. Blood culture remained negative. Sputum and urine cultures negative for blastomycetes. X-ray of lumbar spine revealed a destruction of the fourth lumbar vertebra, as contrasted to negative bone findings on the last admission.

Autopsy Report.—(By Dr. E. S. Walsh). The body is that of a poorly developed and nourished white male weighing fifty-seven kilos and measuring 154 cm. in length.

Numerous foci are scattered over the body surface in the skin. Possibly the largest is situated over the right scapula; another very large one over the left tibial region. Small suppurating lesions are seen in both groins and over the right scapulo-humeral joint. Pressure on any of these lesions yields a thick creamy pus. The general character of all the lesions is much the same in that there is an elevated nodular periphery with a smooth scar-like centre. Crusts are heaped up in places, and over the suppurating lesions the skin is so thin in places that slight pressure causes rupture with discharge of thick creamy pus. The skin of the scrotum is greatly thickened and indurated and several excoriated areas are seen upon it.

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On opening the head a rather noticeable engorgement of the vessels of the pia arachnoid is seen and there is some œdema.

There are about 2000 c.c. of cloudy fluid in the peritoneal sac. This does not coagulate on standing, but fibrin shreads are present in considerable numbers.

The pericardial sac also contains some cloudy fluid and there is a white scar in the epicardium of the right auricle.

The *heart* weighs 220 gms. and the valves measure as follows:

A	7.00 cm.	M	10.0 cm.
P	8.0 cm.	T	11.0 cm.

The left ventricular wall measures 12 mm., the right 5 mm. The myocardium is of a deep red color. The heart is dilated with fluid and clotted blood.

The *lungs* do not collapse when the chest is opened and the right one is loosely bound to the chest wall by delicate fibrous adhesions. Great numbers of shot-like nodules are scattered throughout all lobes of both lungs. In places these nodules have aggregated themselves to form foci of considerable size (2 to 3 cm. in diameter). On section these lesions are only distinguished with considerable difficulty. The places where large numbers of them have gathered together appear as deep red irregular areas. (Lungs fixed for future study.) There is a fibrous lesion at the right apex.

The *liver* is large, pale and smooth, and irregular areas of necrosis are scattered throughout. It weighs 2150 gms. and measures 27 x 19 x 8 cm. There are many spots on the cut surface which have a pale waxy appearance. These are stained brown by iodine but not very distinctly. The gall-bladder is greatly distended with fluid bile which can readily be expressed into the duodenum.

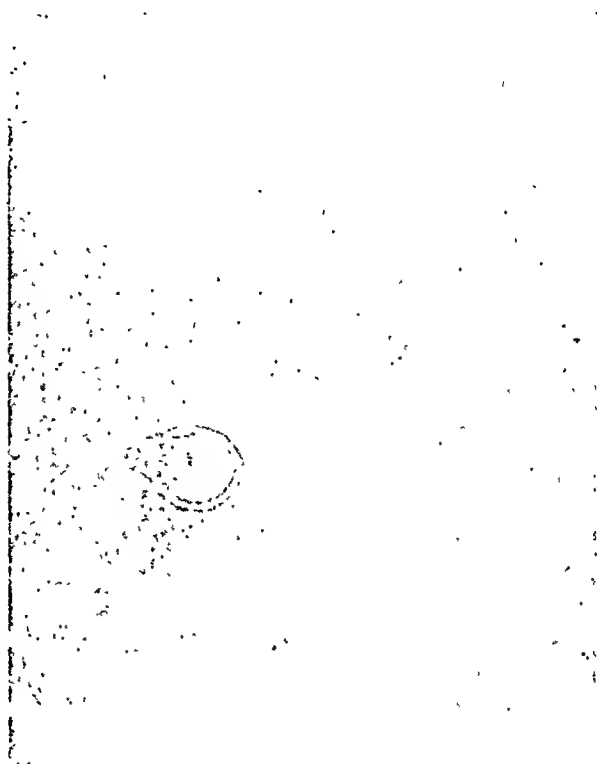


FIG. 5.—High power of a budding organism in the lung of guinea pigs injected intra-peritoneally with the organisms.

The *spleen* is very large and firm and divided into three lobes by two notches. On section, numerous waxy foci are seen scattered throughout the pulp. These do not seem to bear any definite relation to the Malpighian corpuscles as they are located both within and outside the waxy areas. They are stained brown with iodine. The spleen weighs 530 gms. and measures 15 x 11 x 6.5 cm. Several sharply encapsulated tubercles are found in the pulp and one upon the surface of the organ. The pulp outside of the pale waxy appearing foci is rather bright red in color. The capsule is thickened in several places. In addition to the lesions already described there are many very minute gray opaque areas which have a tendency to occur in clumps. These cannot definitely be differentiated from Malpighian corpuscles.

The *pancreas* appears normal. It weighs 135 gms. and measures 23 cm. in length.

The right *kidney* weighs 300 gms., the left 280. One measures 13 x 8 x 3 cm.,

cortex 9 mm. They are pale and smooth. The capsules are rather firmly adherent to them and they seem to be very thin. The surface as well as the cut surface is irregularly mottled by small grayish-white opaque areas. The *adrenals* appear normal. The *pelvic organs* appear normal.

Microscopical Examination.—*Myocardium* appears normal. *Lung*: The histological appearance is that of tuberculosis with the following exceptions. Small aggregations of polymorphonuclear leucocytes, sharply circumscribed, are frequently seen and often form the nucleus of what otherwise would appear to be typical tubercles. Giant cells of the type usually associated with tubercles are abundantly formed in and around the lesions. Yeast cells are present but in very

scanty numbers, and when found are either in the small polymorphonuclear accumulations or in the giant cells. A few budding forms are found. There is some necrosis but little or none of the dead material has the typical appearance of caseous tuberculous tissue.

Liver: A few focal accumulations of mononuclear leucocytes are seen in the periportal areas. The sinusoids are dilated. Amyloid is deposited rather abundantly in the walls of some of the small vessels. The dilatation of sinusoids is most conspicuous at the centre of the lobules and is accompanied by a moderate amount of atrophy of liver cells.

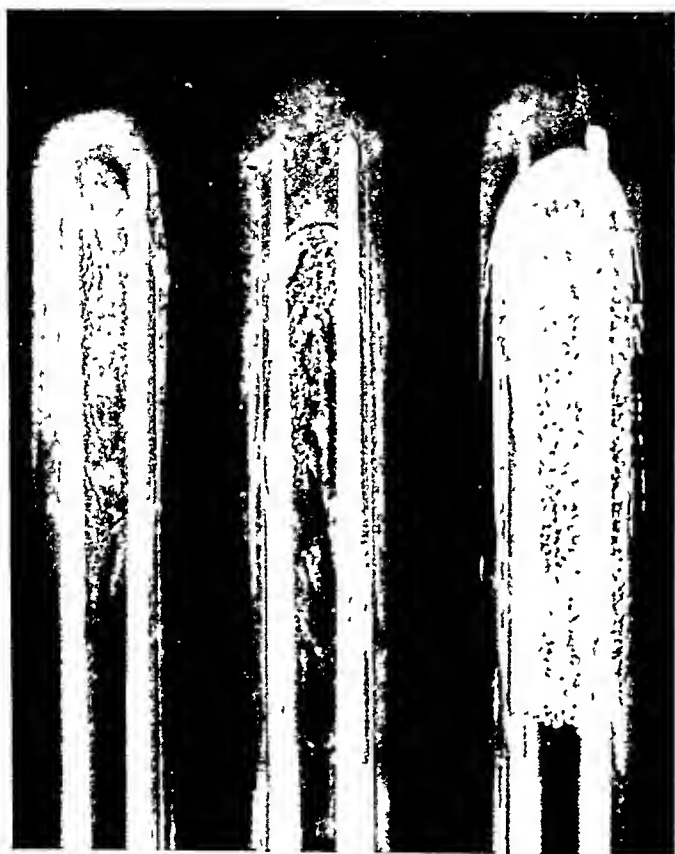


FIG. 6—Culture two weeks of age. From left to right, glucose agar, Russel's media and blood agar.

The *pancreas* appears normal.

The *spleen* is heavily loaded with amyloid which occurs both in and around the Malpighian corpuscles. In the former case the lymphoid elements of the corpuscle are completely replaced by it. The walls of the small blood-vessels are conspicuously involved.

Kidney: There is an abundance of homogeneous material in the glomerular tufts, glomerular vessels, and the walls of many of the larger vessels. This material is stained brown by iodine and red by methyl violet. Hyaline tube casts are frequently seen.

Adrenal: Amyloid seems to be abundantly deposited.

Skin: There is a marked epithelial hyperplasia with numerous papillary downgrowths into the corium. The surface in many places is ulcerated. The corium likewise is thickened and contains numerous plasma cells. Scattered

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about in the corium, adjacent to the distorted finger-like processes of the epithelial layer, are numerous irregularly shaped islands of epithelium. Throughout the entire section, and especially prominent in the Malpighian layer of the epidermis are numerous minute abscesses of varying size. Some abscesses contain only a half dozen or dozen leucocytes; others are large enough to be visible to the naked eye. A relatively large percentage of the polymorphonuclears are eosinophils. In addition to the polymorphonuclear invasion, there is a diffuse mononuclear infiltration. Throughout the section, especially notable in the miliary abscesses, are a moderate number of giant cells. Typical blastomycetic yeast cells, of a

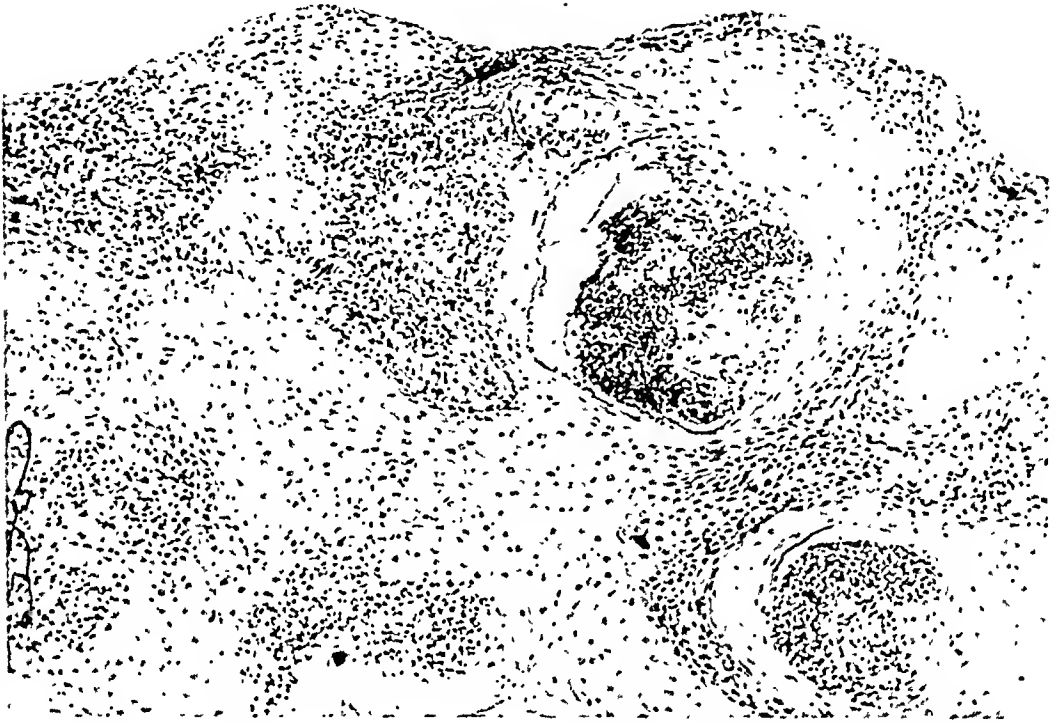


FIG. 7.—Low power of section of patient's skin showing miliary abscesses and hyperplasia of epithelial cells.

description found elsewhere, are seen throughout both layers of skin, usually in the miliary abscesses and frequently in the giant cells.

A set of sections stained with carbol fuchsin and methylene blue are negative for acid fast organisms.

The brain upon cut section reveals no abscess cavities or evidence of inflammation. Culture of heart's blood yielded a hemolytic streptococcus, but no blastomycetes.

Clinical and Pathological Diagnosis.—Pulmonary and cutaneous blastomycosis, blastomycosis of 4th lumbar vertebra, general amyloidosis, fibrino-purulent peritonitis, fibrino-purulent pericarditis, œdema and congestion of pia arachnoid, blastomycosis of epididymis (healed), abscess of jaw, secondary anemia and hemolytic streptococcus septicemia.

Remarks.—As stated, the peculiarity of this case is the scarcity of lesions found at autopsy as compared to the clinical symptoms. However, the organs affected, including lungs, bone, skin, and epididymis represent common locations for disease, excepting the latter. From a review of twenty-two autopsied

cases. Wade and Bel³ found the organs affected in order of frequency were lung, skin, bone, spleen, kidney, liver, lymph-nodes and brain.

The pathology of the lungs on cut section resembled tuberculosis very closely, except as is usually the case in pulmonary blastomycosis, no cavities were found. The exception to this rule is found in a report by Irons and Graham⁴ of a case which had cavities in the lung.

Pathogenicity.—The portal of entry in this case is undoubtedly through a wound of the finger, sustained in an accident in a coal mine. It seems logical

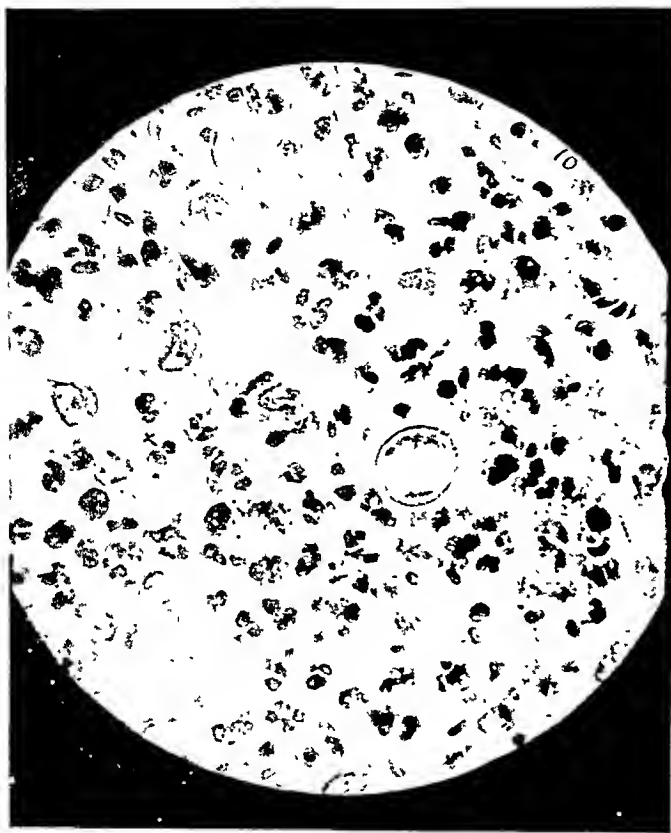


FIG. 8.—High power of a minute abscess containing several organisms. Note the presence of polymorphonuclear leucocytes.

to suppose the mine was the habitat of the organism, but we were unable to obtain history of any similar infection among the miners in this locality. All symptoms of this patient developed after this injury, which produced a stubbornly healing ulcer on his finger. Pulmonary symptoms did not develop until seven or eight months after his initial infection. Study of previously reported cases, however, supports the theory of pulmonary infection as the initial lesion. Montgomery⁵ reported a case whose first symptoms were pain in the chest and which at autopsy revealed blastomycotic abscesses in the lungs. Christensen and Hektoen⁶ also report a case whose first symptom was pain in the chest. The majority of cases of systemic disease, however, gave a history of an initial skin infection.

Although frequent recoveries are encountered among the cases whose disease is limited to the skin, the fatality of systemic infection is almost absolute. Herrick,⁷ however, reported a recovery from systemic infection. A systemic case under the observation of Boughton and Stober⁸ also recovered, but under heavy vaccine therapy. Davis,⁹ however, offers evidence of a very poor immunological reaction, but he was dealing with a different strain of the organism. Although the disease is comparatively a rare one, no less than two physicians have suffered an infection by contact with infected patients.

It is quite certain that the infection is a blood-borne disease even though the primary portal in some cases is the lung. Notwithstanding this certainty, it apparently is very difficult to demonstrate the organism in the blood stream. Krost, Stober and Moes¹⁰ observed one of the few cases from which the organism was obtained by blood culture.

Differential Diagnosis.—Undoubtedly, the disease is much older than records show, but was diagnosed wrongly, probably in most cases as verrucous tuberculosis. Most blastomycotic skin lesions develop faster than verrucous tuberculosis. The former will respond to iodide treatment whereas the latter will not. The pathology is very similar to tuberculosis but polymorphonuclear cells are more numerous than in a tubercle, and eosinophils are found in great numbers. The proliferation of epithelium resembles an epithelioma but the miliary abscesses, eosinophils and presence of organisms are distinguishing features. Syphilis rarely simulates it, and can be excluded serologically and by reaction to salvarsan.

Treatment.—This particular case was treated with iodides, salvarsan, X-ray and local application of mercurochrome. The beneficial value of the former is unquestioned, and was probably first used by Bevan. None of the others, except the local application of mercurochrome, which did stimulate scarring of the lesion, had any effect. Copper sulphate has been used for years both externally and internally but with very little if any beneficial effect. On account of the relatively slow growth of the local lesions, excision should be, and has proven to be a curative measure many times. Obviously, to be a suitable case for excision the infection must be confined to the skin and be accessible to the knife.

Classification.—Curiously, practically every organism reported differs in minor details from all the others. This makes it difficult to establish an accurate nomenclature. All of them, however, might be said to be double contoured yeast-like organisms having no definite nucleus, which reproduce in living animal tissue by budding only, and which under certain varying conditions will produce mycelia. One of the important points of difference between the different organisms reported, lies in animal experimentation. Most strains

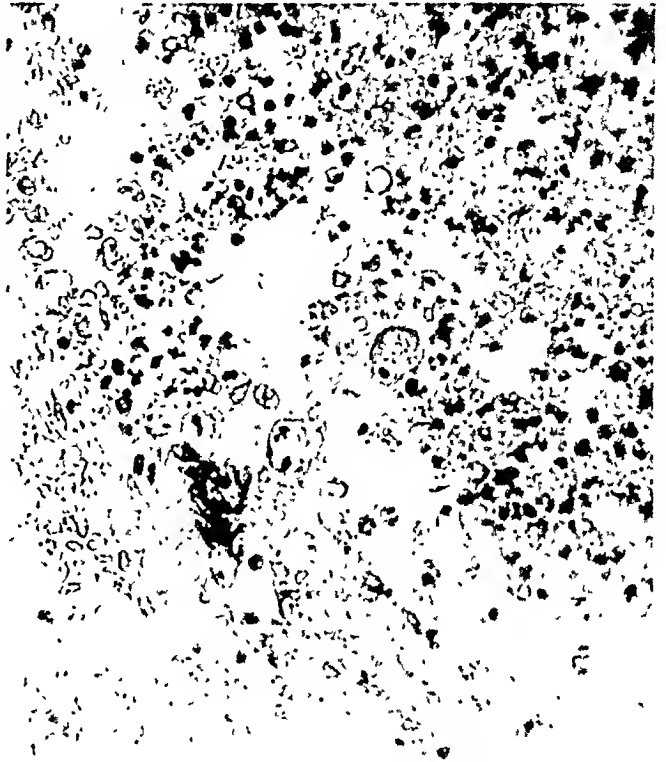


FIG. c.—Moderately high power of miliary abscess containing a budding organism in the lung of the patient.

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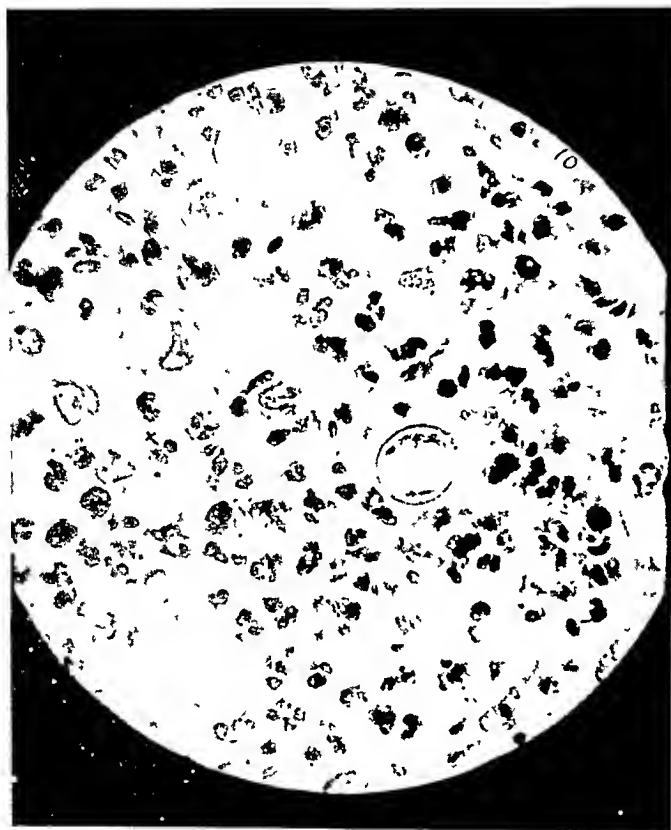


FIG. 8—High power of a minute abscess containing several organisms. Note the presence of polymorphonuclear leucocytes.

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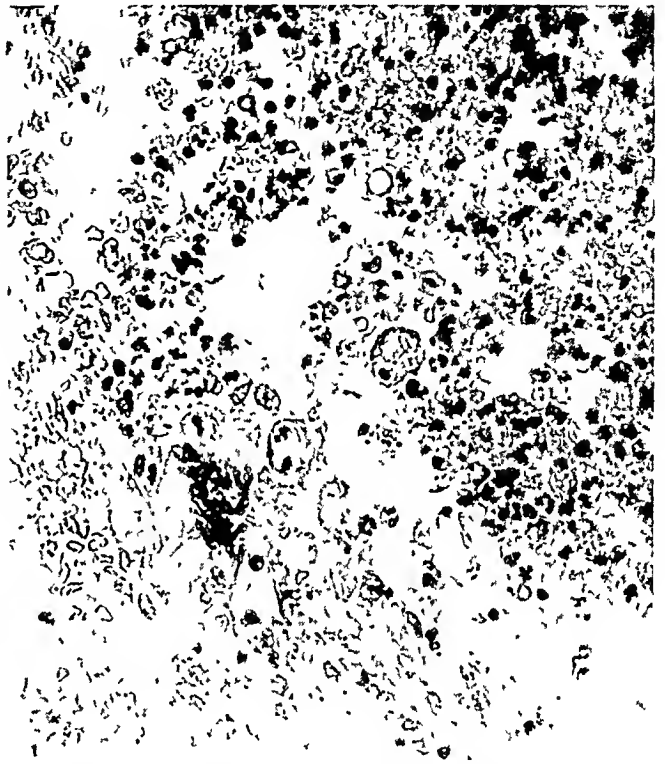


FIG. 9.—Moderately high power of miliary abscess containing a budding organism in the lung of the patient.

are pathogenic to guinea pigs, but Eisendrath and Ormsby¹¹ and many others report negative results from guinea-pig inoculation. An interesting discovery that female guinea-pigs are practically resistant to infection was made by Davis and may in some instances account for negative results.

An organism producing a disease very similar to blastomycosis was described by Rixford and Gilchrist¹² and named *coccidioides immitis* on account of a very slight similarity to coccidia. The striking difference between this organism and the blastomycete lies in its reproduction by sporulation. In many cases, it is difficult to determine whether the causative organism is a blastomycete or the coccidioidal organism. The clinical features are very similar to blastomycosis, but the prognosis is even more serious than in blastomycosis.

On account of the varied cultural characteristics, it has been hard to select a terminology which will include all the various strains of blastomycetes. In view of the fact that a true blastomycete reproduces by budding only, I would prefer to classify these organisms as oidia and call the disease oidiomycosis, especially since oidia present at least a few budding forms. Ricketts¹³ has very satisfactorily divided them into three groups:

1. Blastomycetoid, reproduces by budding, but may produce mycelia.
2. Oidium-like, form submerged mycelia which break up into chains of "spores." Occasional budding form.
3. Hyphomycetoid, produces serial hyphae in addition to having characteristics of the first two.

Whitman¹⁴ has very aptly classified all coccidioidal as well as blastomycotic cases as *Zymonema*.

Under any circumstances it is an evident fact that the organisms form a stepping stone between the yeasts and hyphomycetes.

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TRANSACTIONS
OF THE
NEW YORK SURGICAL SOCIETY
AND OF THE
PHILADELPHIA ACADEMY OF SURGERY

Joint Meeting Held March 12, 1924

DR. JOHN H. JOPSON, in the Chair

HYPERNEPHROMA OF THE SUPRARENAL IN CHILDREN

DR. JOHN H. GIBBON said that the most striking feature of suprarenal tumors in children, and often the first to be observed, is precocious sexual development. This is of the hetero-sexual type with little or no somatic change. These tumors are much more frequent in girls than in boys. In 22 cases collected by Hoag (*American Journal of Diseases of Children*, June, 1923), 19 were girls and 3 were boys. Sexual precocity in boys is usually of the homo-sexual type and is due most frequently to tumors of the testes and the pineal gland. Hypernephroma in children, elsewhere than in the suprarenal itself, does not produce precocious sexual development. It is rare to find in these cases any disturbance of the pituitary, pineal, thymus or thyroid gland, nor has there been any reported case of involvement of both suprarenals. The immediate operative mortality is extremely high, complete removal has not been attempted, or has proved impossible in most of the cases, and in no case reported has there been a complete cure.

The above statements in regard to this very distressing condition are illustrated by the following case, which occurred in the Pediatric Service of Dr. E. E. Graham at the Jefferson Hospital.

The patient was a female child of three years, operated upon at the Jefferson Hospital, February 29, 1924. Four months before admission the parents noticed an enlargement of the abdomen and an excessive growth of hair on the pubes, labia, in the axilla and on the back. The hair grew very rapidly and that on the pubes and labia was nearly as marked as in a girl whose menstruation is well established. This growth of hair was followed by marked over-growth of the eye brows and a growth of down on the upper lip and face. The child was of normal intelligence and exhibited no somatic change. There had been no menstruation, the clitoris was markedly hypertrophied, and at operation the uterus and ovaries were found to be infantile, thus illustrating the statement that the precocity is of the hetero-sexual type. There had been no nervous manifestations, although in a number of cases reported, epileptic seizures are noted. There was no enlargement of the thyroid and the X-ray showed no enlargement of the thymus. There was a huge tumor in the upper left quadrant with marked dilatation of the superficial veins. No blood was found in the

urine on repeated examinations. The Wassermann test was negative and several differential blood counts showed no abnormality. The X-ray examination showed no change in the bones of the skull and no enlargement of the thymus. Carbon dioxide gas was injected in the peritoneum and a diagnosis made of a large tumor in close relation to the upper pole of the left kidney. There was no evidence of lung metastasis.

Under ether anæsthesia an oblique incision was made into the peritoneal cavity, just below the left costal border, and the large tumor readily exposed.

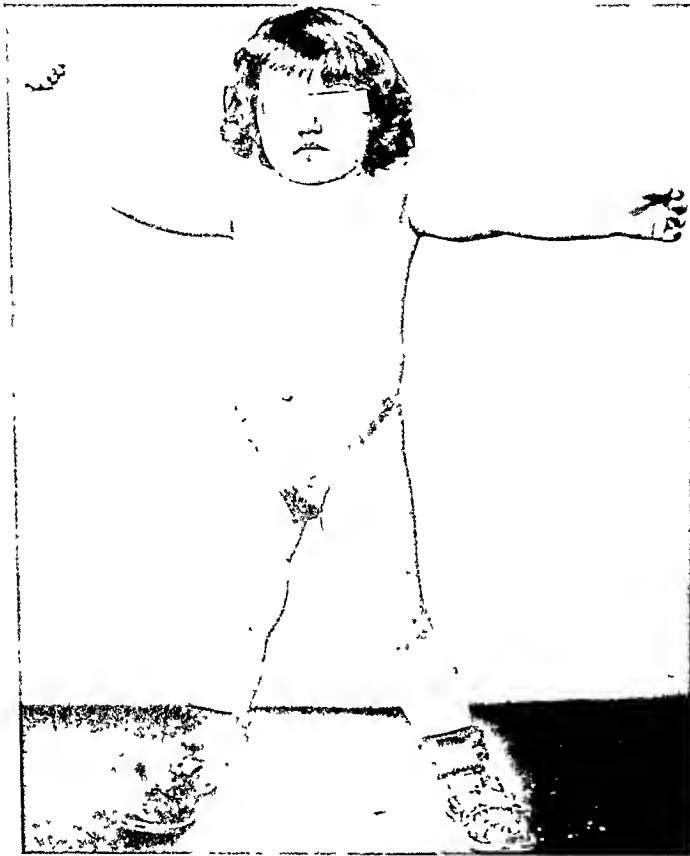


FIG. 1.—Hypernephroma of the suprarenal.

There was no excess of peritoneal fluid and the uterus and ovaries were infantile. The descending colon and splenic flexure were displaced to the right and the posterior peritoneum spread over the tumor contained a large number of dilated vessels. The peritoneum was divided and the tumor quickly and easily enucleated, but not without rupture. The mass was very easily separated from the upper pole of the kidney and there was apparently no involvement of the kidney, which was normal in size. The inner edge of the posterior peritoneum was sutured to the right edge of the anterior peritoneum and in this way the abdominal cavity was shut off. Two

rubber covered drains were inserted and the wound closed. The child was in good condition at the close of the operation, but the temperature began to rise and the next morning it had reached 105° and the respirations were 60. The child died rather suddenly about 20 hours after operation.

Specimen consisted of an encapsulated, rounded mass, weighing 720 gms. and measuring 13 cm. in diameter. Histological diagnosis.—*Hypernephroma*.

INDICATIONS FOR BRONCHOSCOPY

DR. CHEVALIER JACKSON said that he was often asked, in what class of cases of lung abscess he would advise bronchoscopy for treatment. In answer he could very truthfully say in no case whatever should bronchoscopy be used for treatment and thoracotomy delayed. In any case, however, in which for one reason or another the internist or surgeon feels that external

surgery should be delayed it might be well to carry out bronchoscopic aspiration and possibly contribute to the diagnosis. The situation here is different from that which exists in foreign body suppuration in the lung. Foreign body suppuration in the lung has a tendency to get well. Diagnostically and pathologically it differs from post-pneumonic inflammation and suppuration. In the foreign body form there is a barrier built up ahead of the inflammatory process. In others there is no barrier and the suppuration gets in from underneath and proceeds in a different way from suppuration due to foreign body. For instance one of his foreign body cases, a boy was supposed to have a pin in his lung, the mother would not consent to operation and for eleven years he spit up pus. Tuberculosis was diagnosed and the patient kept in bed and outdoors for the most of the eleven years in California. He came to the speaker after being in bed continuously for six months during which time he had gained 15 pounds in weight which was supposed to negative any possibility of the contention of the mother being correct as to the foreign body. The bronchoscope was put down. A pin was located deep in the right lower lobe; the pin was removed through the bronchoscope and the boy got entirely and completely well. This is something one does not see in cases of post-pneumonic or post-influenza processes. There the patients do not recover promptly after bronchoscopy.

Bronchoscopy can contribute in another and important way to the work of the surgeon. It can contribute just as the cystoscopic examination contributes to the work of the genito-urinary surgeon. The genito-urinary surgeon wants to know if pus is present in the urine coming from the bladder or kidney and if from the kidney he wants to know whether one or both and if one, which one. These are things for which he develops certain means of diagnosis. Then too there is the X-ray man. He can tell him something. When the cystoscopist and the X-ray man get together they can tell a good deal more. Just so the bronchoscopist can contribute to the work of the thoracic surgeon. For instance, a patient came to him badly exsanguinated from hemorrhage; had been bleeding off and on for two years; trouble dating from influenza four years before. Patient only twenty-eight years of age. On going down, the bronchoscope in the right lower lobe struck a deformity. This is one great characteristic of cancer of the lung and it was from this deformity that the blood came. A specimen taken from the tumor was reported to be adenocarcinoma. Had it come back negative one would have felt that it was malignant just the same because of the nodular tumor associated with the deformity. In regard to the treatment of lung suppuration.—Suppose when one goes down into the bronchus instead of finding this bronchus normal, one finds the middle lobe of the bronchus ulcerated, granulation tissue and pus streaming from the orifices. If one does not find it in the lower lobe and if the pus below is aspirated and does not recur, one can then tell the surgeon that the suppuration is in the middle lobe. If he decides to postpone operation one can take out the

granulations and aspirate the pus as frequently as necessary with the bronchoscope. Just as the genito-urinary surgeon will set aside certain cases for cystoscopic treatment, just so there are certain cases which the thoracic surgeon will set aside for bronchoscopic treatment.

It is utter folly to hope to remove malignancy through the bronchoscope. But suppose the bronchoscope has been used six months earlier in the case, and given a definite diagnosis when the growth was limited to the interior of the right lower lobe, the surgeon would have had a chance to amputate the lung. When a patient is twenty-eight years of age and suffering from such a condition the patient wants a definite diagnosis. The bronchoscopist gets the specimens and the laboratory makes the diagnosis of adenocarcinoma. Thus is obtained definite information on which to proceed. One wants to be sure about the diagnosis before performing lobectomy. The bronchoscope may help in this. The time has come when the thoracic surgeon has as much need for the assistant familiar with the use of the bronchoscope as the genito-urinary surgeon has for the assistant familiar with the cystoscope.

RADIUM IN PELVIC CARCINOMA

DR. JOHN G. CLARK said that he recently had made a very careful study of the follow-up from the standpoint of five-year cures in cancer of the uterus by the use of radium. In the study of this question one has to take into account the quantity of radium which has been used by the various investigators or applicators. He had one rule which is 100 mgms. for 24-hour application. Formerly he repeated this 2 or 3 times but from the further study of cases as he went on, he came to the conclusion that the impact was made at the first application, and accordingly since then he had sometimes applied it twice but practically never three times. In other words, if the radium does not control the growth on the first application one may hope that something further may occur on the second application but if this fails, never apply the third dose because this is just a supernumerary operation that may do more harm than good. If it does not do much good at the first application he may be skeptical of the future. At first there was the original controversy between abdominal hysterectomy and vaginal hysterectomy. He gave up the vaginal hysterectomy in favor of the abdominal and then finally went to the more radical abdominal operation.

The following tables were submitted:

(1) *Vaginal Operation*

Total of Cases	1205
Operability	654 - 58.1 per cent.
Primary mortality	192 - 9.35 per cent.
Of cases traced	29.67 per cent.
Of cases operated upon	17.75 per cent.
Of cases applying for treatment	9.62 per cent.

RADIUM IN PELVIC CARCINOMA

(2) *Carcinoma of the Cervix*

Total cases	5027
Operability	1720 — 24.31 per cent.
Mortality	1090 — 18.23 per cent.
Of cases traced	35.41 per cent.
Of cases operated upon	19.32 per cent.
Of cases applying for treatment	11.72 per cent.

The objection to the radical operation for carcinoma of the cervix is the high mortality.

The following tables are from the results reported by different men and form an interesting comparison.

(1) *Graves*

Total applying	189 cases
Operability	64 per cent.
No. of operations ..	119 cases
Primary mortality	5 per cent.
Five-year cures	34.2 per cent.

Radical operation for carcinoma of the cervix.

(2) *Peterson*

Total applying	380 cases
Operability	15.7 per cent.
No. of operations	60 cases
Primary mortality	26.6 per cent.
Five-year cures	40.9 per cent.

He was convinced that there is a wide range between what one man calls a radical operation and what other men call radical. In other words one sometimes starts in to do a radical operation, but does not do it although the chart states that he did. Here too is seen the wide range between two men as to what they consider operability. The only way to calculate statistics is from the standpoint of how many cases one has seen in the course of a year and at the end of five years how many of these are alive. All men vary; one day if one feels particularly peppy and looks at a case, he calls it operable; the next day if one is not so peppy and were to see the same case for the first time he would probably say it was not operable. Much depends on the way the individual feels.

(3) *Martzloff*

Total applying	387 cases
Operability	46 per cent.
No. of operations	178 cases
Primary mortality	14.2 per cent.
Five-year cures	26.6 per cent.

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These results are from the Johns Hopkins Hospital and are not from clinical studies alone but from the laboratory reports, so that they found there were some cases which ten years before were diagnosed as carcinoma but which today laboratory men would not consider such owing to the endometrial changes. One will notice from these charts the great range of operability and mortality statistics.

(4) *Bailey and Healy*

Operability	27 per cent.
Border line cases	24 per cent.
Inoperable	14.5 per cent.
Recurrent inoperability	22 per cent.
All cases over five years.	

(5) *Burnham (These statistics are not up to date)*

Operability	50 per cent.
Border line cases	24 per cent.
Inoperability	9 per cent.
Recurrent inoperability	11 per cent.

(6) *University Hospital*

No. of cases	144
Operability (22)	27.2 per cent.
Inoperability (118)	6.7 per cent.
Recurrent inoperability (4 cases 1 recovery) .	25 per cent.
Total five-year cures	10.4 per cent.

Radical operation had 8 per cent. mortality. He thinks the cases were all in the operability class. The best results he had ever received before using radium was 33 per cent. with 8 per cent. mortality. My own experience could not be compared with that of anyone else, but he thought the present radium statistics are better than his previous statistics. The radium treatment means two or three days in the hospital at the most, with immediate return to the home for the patient, and the whole picture is better. So even if one does not get any better results with radium than with the radical operation, one has at least helped the surgeon, has done a service to the patient from the economic standpoint. Of the large number treated there will be a considerable number who never bleed again and in whom the discharge is reduced to a minimum, a certain number who are relieved of pain. As time goes on and he studies his cases, he finds few operable cases, and most of these come at the end of the day when his operable judgment is not its best. He has not entirely given up the operation but had only done three or four cases a year and these mostly on tradition. The results he had shown are for his first five years of radium treatment and he believed those for the next five will be better. He practically never applies radium now without anaesthesia, he now thoroughly packs the vaginal wall as he found that he could not apply the lead plates without packing and not have

COMPOUND FRACTURE-DISLOCATION OF ELBOW

here and there a crevice for them to get through with the possibility of burning a hole in the rectum or vagina. The first series had a large percentage of fistulæ. Doctor Keene informs me that since 1920 we have had no fistula cases following radium application and he attributes this to the more careful application with anæsthesia and the packing back of the antero-posterior wall away from the radium.

COMPOUND FRACTURE-DISLOCATION OF ELBOW

DR. JOHN H. JOPSON presented a man, fifty-six years of age who was admitted to the Presbyterian Hospital, November 28, 1923, having been struck by auto. Sustained lacerated wounds of scalp and eye-brow, an impacted fracture of the stump of an old amputation of right arm below the shoulder, and a fracture-dislocation of the left elbow, compounded; also abdominal contusions. X-ray showed an impacted fracture of the surgical neck of the right humerus stump, a fracture of the left olecranon process, the detached fragment pulled upward and backward, with an anterior dislocation of the shaft of the ulna, and the head of the radius, both riding forward and upward on the anterior surface of the condyles. There was a wound the size of a lead pencil on the posterior surface of the elbow, communicating with the fracture of the ulna. There was considerable swelling of the elbow. The patient complained of pain especially in right shoulder and abdomen. Attempts were made by Doctor Pfeiffer and Doctor Jopson to maintain reduction by traction from elbow outward, using 8 pounds weight, in combination with an internal angular splint. The fracture of the humeral stump was impacted, and required no special dressing. An X-ray made on December 3, showed little change in position. The wound in elbow was granulating. On December 4, 1923, reduction was effected under anæsthesia and the arm re-dressed on a right angle splint. The following day traction was added over upper surface of forearm. On December 12, straight extension was applied to overcome the recurring displacement of both bones, but without effect. The wound was not healed sufficiently at this time to permit of the open operation which was seen to be needed. On December 21, 23 days after the injury, the wound being healed, an open operation was performed. Two incisions were necessary. A straight posterior one over the elbow, in the median line, and a Kocher incision over the outer condyle and head of radius. The head of the radius was excised, and a portion of the upper end (articular surface) of ulna removed, before the detached olecranon process could be approximated to the shaft of the ulna, where it was fixed by two silver wires, passed at right angles through drill holes in the bone fragments. This maintained reduction, and a plaster case was applied with elbow flexion nearly at right angle. The wounds healed cleanly, and the case was removed on January 12, 1924, the X-ray having shown perfect reduction of dislocation and apposition of fragments. A removable plaster dressing was applied, and light massage and assisted active movements begun. The fixation of the joint at this date was almost complete. All dressings were removed after 5 weeks, and massage, hot packs and general physio-therapy measures begun. The man still in hospital. Movement improving. Supination and pronation incomplete, about 50 per cent. of normal motion. Flexion and extension still limited, but improving. About 60° of motion 12 weeks after operation. Arm is strong; can push and pull with strength. This is important, as this man is a switchman, and has but his left arm to depend upon to earn his living.

SEPARATION OF LOWER EPIPHYSIS OF THE FEMUR WITH FRACTURE
OF THE SHAFT OF THE TIBIA

DOCTOR JOPSON presented a girl, aged seven years, who was admitted to the Presbyterian Hospital, June 28, 1923. On the preceding day she jumped down from a stone wall on which she had been sitting. A large stone was displaced as she jumped, and struck her on the posterior surface of the left lower extremity. On admission the left knee and leg were swollen. At least one-half inch shortening was present. There was an anterior displacement of the knee, due to forward and upward displacement of the lower femoral epiphysis with overriding, and a transverse fracture of the tibia, middle third, with forward displacement of the upper fragment. The problem presented was to effect and maintain reduction of the femoral epiphysis, as well as of the fragments of the broken tibia. Doctor Speese and Doctor Jopson had treated supracondyloid fractures of the femur with tongs extension in the last few years, and with satisfactory results. They had used skeletal traction in a number of cases of fracture of other types which were formerly treated by open operation. Doctor Jopson applied tongs to the epiphysis in this case and used extension in conjunction with the Thomas splint, balanced suspension and self-contained traction over the end of the splint, using 8 pounds weight. The knee-joint was flexed, and the leg encased in moulded plaster splints, and supported on a Cabot splint attached to the Thomas splint. Three days later X-ray showed reduction of overriding of the epiphysis, but 20° forward angulation remained. This was overcome by bending the Thomas splint above the knee, changing the direction of pull on the epiphysis. The tongs were removed after 9 days, and the fixation maintained by bandaging the thigh to splint, and continuing suspension. X-ray showed good position on this date. One week later the leg and thigh were encased in plaster, with the knee slightly bent. The case was split before discharge, on July 23, to her home in the country, with instructions to remove it at the end of 8 weeks, after which guarded use of the limb was to be begun. The results in this case were very satisfactory. Various methods of effecting and maintaining reduction are advised in displacement of this epiphysis, and most authorities emphasize the danger of displacement of the epiphysis after apparent satisfactory reduction. This is the only case in which he had used tongs traction in children, but in the Bellevue Hospital series reported by Burdick and Siris, (*ANNALS OF SURGERY*, June, 1923) calipers were applied in 5 cases of fractured femur in a total of 268 cases, and credit given the method as a means of avoiding open operation.

DR. MORRIS K. SMITH (New York) said that one reason why cases of separation of the lower femoral epiphysis are regarded with dread is, that the type of accident causing them is likely to be so severe that the associated injuries add to the seriousness of the case. MacAusland has collected thirty-six cases of which ten came to amputation and four died.

It was his own impression of separated epiphysis that union sets in more promptly than after diaphyseal fractures, so that a delay in coming to reduction may increase the difficulties disproportionately.

He had recently had a case of separation of the lower femoral epiphysis in a boy of twelve years of age who, while climbing a fence, fell with his shoe caught in a picket. The lower end of the shaft was displaced posteriorly

into the popliteal space as in Doctor Jopson's case. He was fortunate in seeing him within two hours of the injury. Under anæsthesia it was possible to reduce the displacement by extension, but by flexing the knee, traction and pushing the upper fragment forward, reduction was satisfactorily accomplished. The leg was maintained in flexion with adhesive plaster strapping for two weeks. The boy left the hospital on crutches at the end of three weeks, and was walking without crutches within two months.

It is too early to know whether shortening will eventuate, but the study of end results in separated epiphyses leads one to emphasize that the prognosis should be guarded.

DR. JOHN GERSTER (New York) reported the case of a girl of eight with a transverse supracondylar fracture of the femur at the epiphysis, easily reduced by manipulation in extreme flexion and maintained in this position; the child was walking perfectly at the end of four weeks.

A case similar to that of the elbow fracture reported by Doctor Jopson was in a powerful young man injured in a motor-cycle accident. A slightly compounded fracture of the olecranon whose line of fracture running transversely through distal half of articular surface of ulna, permitted lower fragment of ulna and radius to move together freely up anterior surface of humerus, was immediately operated through a lateral longitudinal curved incision one-half inch to outer side of ulna, the subcutaneous aspect of bone being exposed and a four-screw Lane plate applied. Passive motion from the first day. Lane plate removed under local anæsthesia four weeks later. Several years later (in 1917) he was passed by Draft-board as he had no physical disability. In addition to his elbow injury he had a simple oblique fracture of the upper third of femur (treated by nail extension for three weeks and then plated at open operation) and a compound comminuted fracture of both bones of the leg—lower third—(plaster case). All fractures were on same side of body.

DR. JOHN H. GIBBON (Philadelphia) thought that in all elbow fractures, too much attention was paid to exact co-adaptation of fragments and the fixation of the joint and urged the importance of early passive and active movements. As the preservation of flexion is of the greatest importance, he thought that even neglect of the olecranon fracture might be advisable in certain cases, in order to preserve flexion and keep up motion; even where the olecranon is fixed by open operation to the shaft, the arm should be dressed in acute flexion and early motion practiced. Unless there is wide separation of the olecranon from the shaft, one can count upon a fibrous union with a good functional result. Nature does a great deal by shortening muscles to make up for a permanent separation of the fragments, if there is a good fibrous union. One often sees wide separation of the patella, following fractures, with a fibrous union and a good function. Early and constant movement he considered one of the most important parts of the treatment.

In regard to the separation of the lower femoral epiphysis, he also urged the fixation of the leg in acute flexion and early motion. He advised against

the use of case or splint in these cases and recommended that acute flexion be maintained by a figure-of-eight passed about the ankle and thigh.

DOCTOR JORSON in closing, said that in the case of compound fracture dislocation of the elbow, he agreed that immediate operation would probably be preferable. Should he encounter another such case he would operate immediately, if conditions permitted. He did not agree with Doctor Gibbon when he advises not to operate in such cases. The wide separation of the fragments would greatly diminish the strength of the arm, and an operation

would certainly be required eventually. He recalled one such case in which Doctor Pool operated for non-union of the olecranon, and secured a good result, but had to do a plastic lengthening of the triceps tendon. The same thing sometimes happens in fractures of the patella. He had operated on two cases in which a failure of bony union followed non-operative treatment of the fracture, in both of which the patients were crippled before operation and were completely cured after operation.

EXCISION OF A BRANCHIAL FISTULA

DR. ASTLEY P. C. ASHHURST showed a man, nineteen years of age, on whom he had operated at the Episcopal Hospital, December 19, 1923. The patient complained of a more or less constant semi-purulent discharge from a minute opening on his neck, situated at the anterior border of the right sternomastoid muscle, about 3 cm. above the clavicle (Fig. 1). The



FIG. 1.—Branchial fistula, discharging at lower end of anterior border of right sternomastoid muscle. Note ++ on borders of picture, as guides to site of orifice.

patient pointed out that a cord, about the size of a pencil, could be felt running upward from this point for a few centimetres, when it seemed either to stop or to become lost in the deeper tissues. The patient stated that he had had this discharging sinus, to his knowledge, since the age of five years; and that it was a constant annoyance, staining his underwear and making him uncomfortable. Whenever he swallowed, this sinus was retraced a little upward. He presented no other abnormalities. A diagnosis of branchial fistula was made, and Dr. W. R. Watson, otolaryngologist to the hospital was

EXCISION OF A BRANCHIAL FISTULA

asked to examine the pharynx: this he reported as normal; the lad's tonsils had already been removed.

Operation.—December 19, 1923.—Ether was administered by intrapharyngeal tubes. The fistula was injected with melted paraffin, its orifice being barely large enough to admit the end of a fine cannula. An incision about 10 cm. long was made in the line of the skin folds, excising an island of skin including the fistulous opening. On dissection, the tract, which was about the size of the omohyoid muscle, was found to extend upward along the anterior border of the sterno-mastoid muscle as far as the upper border of the thyroid cartilage, where it became deeper. To expose it better, a second incision, 7 cm. long was made in the same direction as the first, below the border of the mandible. The portion of the fistulous tract already dissected was then delivered through this upper incision, and traced further. It passed between the external and internal carotid arteries, and was followed to its

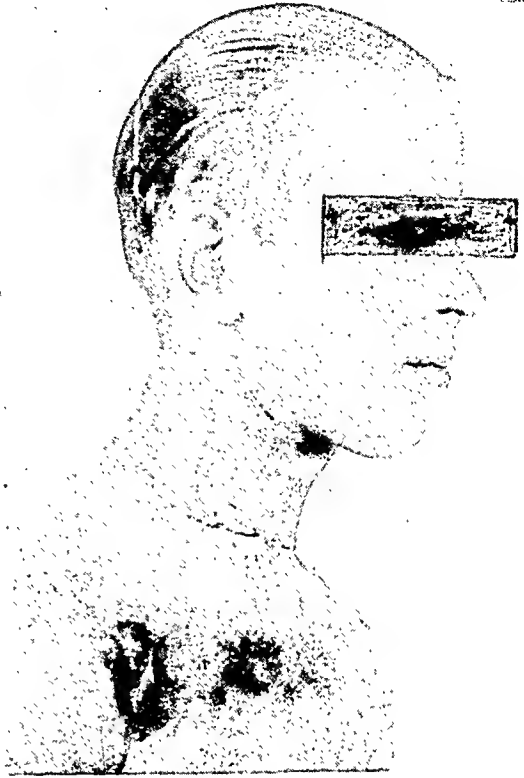


FIG. 2.—Patient eleven days after operation—inconspicuous scars.

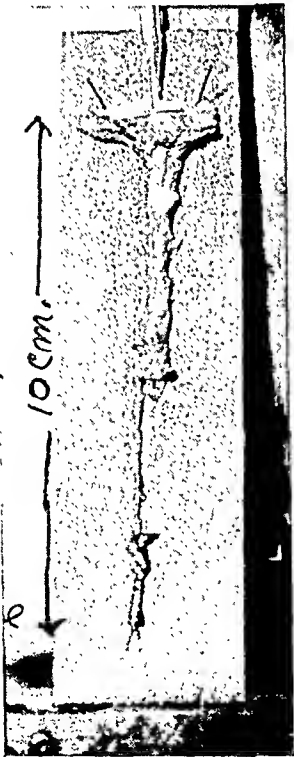


FIG. 3.—Specimen of branchial fistula, after hardening and shrinking in formalin.

origin in the wall of the pharynx just below the digastric muscle. Every time the patient swallowed the tract was drawn up toward the pharynx, and its attachment to the pharynx was seen to be funnel-shaped. The end of the tract was ligated, the tract cut off, and the stump swabbed with carbolic acid, and then buried by a purse-string suture of chromic catgut, as the appendix stump is treated. There was considerable difficulty in placing the purse-string suture, owing to the depth of the wound and the comparative thinness of the pharyngeal wall. During the dissection the fistulous tract broke almost in two at one point, while rather strong traction was being made on it; pressure on it then caused an extremely fine pencil of paraffin or inspissated pus to exude from its lumen. This pencil of paraffin was about the size of an ordinary cambric needle—one-half to three-quarters of a millimetre in diameter. As the upper and lower neck wounds communicated with each other by an opening only just large enough to thrust the fistulous tract through, it was thought safer to drain each wound separately, with a strip of rubber tissue.

The wounds were closed in layers with chromic catgut, and with lock stitch of equisetene for the skin.

The drains were removed after 48 hours, and the incisions healed promptly, leaving inappreciable scars (Fig. 2). On the third and fourth days after operation

there was some swelling and pain in the right tonsillar fossa. Dr. W. R. Watson examined the throat about two weeks after operation and found no evidence of any abnormality. For some weeks after operation the patient complained of pain in the throat at the site of the purse-string suture, but this gradually disappeared, and at present, three months after operation, he is free from symptoms. As the entire tract was removed, there is no reason to fear a recurrence.



FIG. 4.—Microphotograph of cross-section of branchial fistula in its upper third; showing the lumen lined by stratified columnar ciliated epithelium; lymphoid tissue in the walls; muscle tissue at the periphery.

The fistula, after hardening in formalin measured about 10 cm. in length (Fig. 3).

Microscopical examination was made by Dr. C. Y. White of sections cut from the specimen at four different levels. These showed a tube lined by stratified ciliated columnar epithelium, except in the section from the extreme end near the pharynx, which showed no lumen. The section nearest the skin showed no lymphoid tissue in the walls of the tract; that next above showed a little lymphoid tissue; the third showed much lymphoid tissue (Fig. 4); while the fourth, at the pharyngeal wall showed only muscle.

INSULIN IN SURGERY

DR. JOHN SPEESE (Philadelphia) said that the introduction of insulin has so revolutionized the treatment of diabetes and the results of its use are so well known that it is unnecessary to dwell upon the medical aspect of the question. The interest now is more particularly in ascertaining to what extent insulin can be used in surgery or in surgical cases complicated by diabetes, the latter constituting a class regarded as critical and in which surgical intervention has not always been followed by the most encouraging results.

Diabetic acidosis is controlled so readily by insulin that its use in other conditions, giving rise to acidosis, naturally followed. Insulin may have its greatest use, from the surgical point of view, in the treatment of various forms of acidosis, whether pre-operative or post-operative. It is a well known fact that if glucose is given by rectum, subcutaneously or intravenously there is a gradual disappearance of the acidosis encountered in a variety of conditions. Since insulin causes rapid utilization of glucose in the body it follows that its injection ought to clear up the effect of acidosis

INSULIN IN SURGERY

more rapidly than when glucose alone is given. While the number of reports of patients so treated is comparatively small, the results are encouraging and indicate that the intravenous administration of glucose controlled by insulin makes safe for operation many cases of starvation acidosis and controls the acidosis seen in post-operative conditions. Pre-operative acidosis constitutes a grave complication of the condition for which surgical intervention may be necessary, and may be so severe that valuable time is lost in the treatment by glucose injections alone. Response to its use with insulin is so prompt that many desperate cases may be saved by this more rapid and more specific method of treatment.

In diabetes complicated by infection, insulin by rapidly controlling the diabetes raises the patient's resistance and increases his chance to combat the infection. In such cases active measures against the infection should be instituted early and valuable time not lost in an attempt to control the diabetes with insulin. In several cases of severe wide-spreading infection, insulin had little or no effect upon the diabetic acidosis until the infected area was excised.

In rapidly spreading gangrene of the moist variety with acidosis associated with diabetes, and probably increased by absorption from the gangrenous part, immediate amputation followed by insulin therapy has given better results than preliminary insulin injections followed by amputation. In the dry variety of gangrene, on the other hand, with less infection and less acidosis, preliminary treatment with insulin can be used with less danger of delay. Several cases of incipient or threatened gangrene in diabetes seemed to be prevented by insulin.

There is no doubt that diabetic patients undergoing operations for chronic surgical conditions can be rendered good surgical risks by a combination of dietetic treatment and insulin. Many cases apparently hopeless from acidosis and coma first have been treated with insulin after which the surgical lesion has been attended to successfully. The effect of dietary measures alone is not to be minimized for such regulation accomplished much heretofore. Insulin, however, assures a more rapid response in the treatment preparatory to operation.

He had had the opportunity of administering insulin in the post-operative treatment of one case of acute hemorrhagic pancreatitis complicated with calculous cholecystitis. Drainage of the gall-bladder and pancreas was performed, on the following day there was a pronounced increase in blood sugar, acidosis and impending coma. The use of insulin with active carbohydrate administration was responsible for the rapid disappearance of the acidosis and hyperglycemia. Later a normal blood sugar ratio was controlled and maintained by regulation of the diet and insulin injections. In conclusion he emphasized the necessity of careful medical supervision of these cases, both in the administration of insulin and in the regulation of the diet.

NEW YORK SURGICAL SOCIETY

ACUTE MECHANICAL INTESTINAL OBSTRUCTION TREATED BY HIGH TEMPORARY JEJUNOSTOMY

DR. WALTER ESTELL LEE (Philadelphia) read a paper with the above title for which see page 45.

DR. SEWARD ERDMAN (New York) believed that the high enterostomy which has been brought to the notice of the surgical world in recent years, is of the utmost importance in the treatment of ileus whether of mechanical origin or of the paralytic type which latter so often accompanies peritonitis. During the past three years he had had the opportunity of following this method of treatment as applied to appropriate cases on the Second Surgical Division of the New York Hospital in the service of Dr. E. H. Pool. Including cases in private practice, they had now a series of 35 jejunostomies, two of which were for the sole purpose of feeding. There remain 33 cases performed for the relief of ileus associated with peritonitis and the mortality was 51 per cent. All of these were desperate cases where the expectant mortality is extremely high in the presence of spreading or general septic peritonitis and they feel that 49 per cent. recoveries represents the benefit of high intestinal drainage in such cases, and that some lives were thus saved.

The advantage of early intervention is shown by the fact that in those cases operated upon and the jejunostomy performed within 48 hours of the onset of ileus symptoms, the mortality was only 35 per cent., whereas in cases where jejunostomy was delayed to the third day or later, the mortality rose to 63 per cent. The 33 cases include fifteen jejunostomies for general peritonitis from acute appendicitis; eight for peritonitis of pelvic origin; five for peritonitis from traumatic rupture of the intestine; three for strangulated ventral hernia, and two for unusual forms of pyloric obstruction. One of the pyloric cases developed high obstruction immediately following the resection of the jejunal ulcer at the site of a previous gastro-enterostomy. In this case they performed early a jejunostomy for feeding and at the same time a Witzel gastrostomy for drainage of the stomach.

The relief of vomiting was immediate and jejunostomy feeding was very effective. After three days both tubes were withdrawn and the wounds healed promptly with relief of all symptoms.

DOCTOR VAN BEUREN (New York) reported statistics at the Presbyterian Hospital from Dr. Beverly Smith of 59 cases of enterostomy done in the ten years preceding 1916. Of these there were 47 done for acute intestinal obstruction. About 45 per cent. of these patients had peritonitis more or less diffuse. The mortality in cases of enterostomy (high or low) in cases of acute ileus was 90 per cent. Now the general mortality in cases of acute ileus was something like 50 per cent. It was, therefore, very surprising to find that the enterostomy which is expected to increase the chances of survival actually appeared to have increased the mortality. On going over the cases in some detail it was discovered that in very many of them the enterostomy was not performed until a relatively late moment in the course of the disease and that death occurred within a few hours after the enterostomy.

FECAL FISTULA

He was finally forced to the conclusion that enterostomy had been used in most of these cases rather as a last resort than as prophylatic or curative procedure. It ought to be emphasized again that enterostomy is a procedure which should be employed early. Other things being equal, the severity of the symptoms in proportion to the length of time they have existed should give one a lead as to whether to operate or not and, if operation is performed, whether an enterostomy should be included in the operation or not. The more severe the symptoms in proportion to the time that they have existed the more urgent the need for operation and the more probable the need for enterostomy. The procedure outlined by Doctor Lee is the one which had been in use at the Presbyterian Hospital for the last two years.

FECAL FISTULA

DR. JOHN B. DEEVER read a paper with the above title for which see page 56.

DR. WALTON MARTIN (New York) said that there are two important things to consider: whether the fistula is due to the stump of the appendix or due to erosion or sloughing of the bowel wall. Doctor Deaver had mentioned the rigid drainage tube and thought it might be a factor in producing necrosis. The speaker had not had occasion to see many cases due to this in the last few years. Another type is that where fecal concretions escape from the appendix opening and remain at the bottom of the sac.

TRANSACTIONS

OF THE

NEW YORK SURGICAL SOCIETY

Stated Meeting Held March 26, 1924

The President DR. EUGENE H. POOL, in the Chair

SUBTOTAL GASTRECTOMY FOR RECURRENT GASTRIC ULCER

DR. RICHARD LEWISOHN presented a woman, sixty-five years old, who had been previously operated upon by another surgeon at Mount Sinai Hospital in November, 1922. At the time of her first admission she gave the following history: She had suffered from gastric distress for twenty years. During the last year she had very severe pains. X-ray examination showed a penetrating ulcer of the stomach with about $1/5$ residue after 6 hours. A pre-operative transfusion of 500 c.c. of citrated blood was given. Operation revealed a penetrating gastric ulcer, adherent to the pancreas. The adhesions were freed and the ulcer excised with knife and cautery. The defect was closed in layers. No gastro-enterostomy. The symptoms recurred a few weeks after the operation. X-ray examination revealed a recurrent penetration with more than $1/3$ residue after 6 hours. Ewald test-meal: free Hcl. 45, total acidity 55. She was sent to the dispensary for further observation and treatment.

The patient was re-admitted to Mount Sinai Hospital in October, 1923. Her suffering had been so intense during the last few months that a secondary operation was indicated. Re-laparotomy revealed a large crater ulcer (size of a quarter) on the posterior wall of the stomach with dense adhesions to the pancreas and posterior parietes. The ulcer extended almost to the level of the cardia. The stomach showed moderate hour-glass formation.

A subtotal gastrectomy was performed. The base of the ulcer was left adherent to the pancreas. Closure of the duodenum in three layers. Button gastro-enterostomy between stump of the stomach and jejunum. A citrate transfusion (750 c.c.) was given after the operation. The patient made an uneventful recovery. The button was passed about seven weeks after the operation.

The specimen shows that about $4/5$ of the stomach was removed. The patient states that she is free from pain since the second operation. X-ray examination shows that the stoma functions perfectly.

PARTIAL GASTRECTOMY FOR DUODENAL AND GASTRO-JEJUNAL ULCER

DOCTOR LEWISOHN presented a man, forty-one years old, who had undergone two previous operations on the stomach. These operations were performed at Mount Sinai Hospital by another surgeon.

The first operation which dated six years back, consisted of a suture gastro-enterostomy without exclusion for duodenal ulcer with pyloric obstruction.

He was perfectly well for over five years. Seven weeks before his second admission to the hospital (1922) pains and vomiting recurred. X-ray ex-

amination revealed an irregular, tender stoma, one-half residue after three hours and a large residue after nine hours. Diagnosis: gastro-jejunal ulcer. Five days after his admission he had a very profuse hæmatemesis which required a transfusion of 500 c.c. of citrated blood.

Exploratory laparotomy (January, 1923), showed a dilated stomach, which was imbedded in so many adhesions that it could not be delivered. An indurated mass (gastro-jejunal ulcer) was palpated at the stoma. A small hard mass, about 1 cm. in diameter, was felt at the pylorus, apparently with a crater in its centre. The pylorus was densely adherent to the gall-bladder. During the attempt to free these adhesions the pylorus was entered. The opening was closed in layers, after a small piece had been excised for pathological examination (inflammatory tissue). The patient's condition was so poor that it was impossible to attempt any radical procedure. The abdomen was closed. Immediately following the operation a transfusion of 500 c.c. of citrated blood was given. After this transfusion the hæmoglobin was 36 per cent.

The patient vomited large amounts of dark blood following the operation. The hæmoglobin had fallen to 18 per cent. on the seventh day post-operative. Another citrated transfusion brought the hæmoglobin back to 35 per cent. The patient's condition improved gradually and he was transferred to the medical service where irrigations with colloidal iron (Epstein treatment) were given. He was discharged about two months after the second operation in good condition.

Patient was admitted to Doctor Berg's service at Mount Sinai Hospital in September, 1923. He had recurrence of his old symptoms for one week. He vomited large amounts of blood on the day of admission. An immediate transfusion of citrated blood brought his hæmoglobin from 20 per cent. to 30 per cent. Another blood transfusion (Unger method) was given a few hours before the operation. In spite of a fairly high hæmoglobin (48 per cent.) the patient looked extremely pale and was a very bad operative risk. However, the only possible way of saving this man's life seemed to be a radical operation which would definitely prevent recurrence of the hæmatemesis.

The operation (September 15, 1923) revealed a large gastro-jejunal ulcer and a duodenal ulcer between the 1st and 2nd portions of the duodenum. Extensive adhesions between the stomach and the abdominal wall were freed, the colon was separated from the gastro-jejunal induration. The gastro-enterostomy was discontinued and the jejunal opening closed. At this point the anæsthetist reported that the pulse was imperceptible. An intravenous saline infusion was given. On account of the patient's precarious condition separation of the duodenal ulcer from the pancreas was contraindicated. The stomach was resected just beyond the pylorus at its distal end and beyond to the old stoma at its proximal end (Finsterer operation). A large crater ulcer could be seen in the duodenum after the stomach had been cut across. Both duodenum and stomach were closed in layers and a button gastro-enterostomy was performed. The patient made an uneventful recovery. The button was passed a few weeks after the operation. X-ray examination shows perfect function of the stoma. Ewald test-meal shows: free Hcl. 5, total acidity 30. It is interesting to note that the duodenal ulcer had persisted in spite of the fact that the patient had the benefit of a gastro-enterostomy for seven years. The patient has gained twenty pounds since this operation.

DOCTOR LEWISOHN stated that in discussing cases in which primary radical procedures had been employed in order to establish a permanent cure, the objection was often raised that more conservative operative measures might have cured the patient. In these two patients conservative procedures had been tried without avail. If at the time of the primary operation a partial gastrectomy had been performed, these patients would have been definitely cured by one, instead of by two and three operations.

DR. JOHN F. CONNORS said that he was at a loss to know what to do for gastric ulcers. He did not believe that gastro-enterostomy is a cure for gastric ulcers and he firmly believed there is only one indication for it and that is pyloric obstruction. He realized that in the hands of most men, himself included, they cannot hope to obtain the low mortality obtained at Mt. Sinai Hospital until they have had a wider experience with this operation. He felt like one in the dark and hoped some day that a better understanding will come as a result of the partial gastrectomy on one side and a gastro-enterostomy on the other and all shall see the light as to truly what is the best operation in these cases.

BONE GRAFT FOR WIDE SEPARATION OF SYMPHYSIS PUBIS

DR. FREDERIC W. BANCROFT presented a woman who had suffered a fractured pelvis, September 18, 1920. When admitted she was in shock, complaining of pain in the stomach and legs following an automobile accident. She vomited several times following the accident. She complained also of pain in the lumbo-sacral region, left ankle, and in the pelvis, her scalp was lacerated.

Physical examination showed tenderness over the iliac crests; large ecchymosis of the right labium, contusion and hæmatoma of the left ankle, contusion of the back in the lumbo-sacral region. X-ray September 20, 1920, showed fracture and dislocation of the pubis and fracture of the ascending ramus of the right ischium. X-ray September 28, 1920, fracture of the posterior os calcis (left); separation of pubic bones and fracture of the right ramus. She recovered being left with distinct waddle, walking with great difficulty due to a permanent separation of the symphysis pubis.

November 1, 1921, Doctor Bancroft operated for the purpose of making a bone graft transplantation to relieve the separation of the symphysis. Pfannenstiel incision over pubis.

1. Scar tissue dissected away. Both ends of the symphysis were isolated. They were separated about $2\frac{1}{2}$ inches. There was considerable atrophy and both ends were surrounded by bursæ. Scar tissue between the fragments was separated free. Fragments were thoroughly isolated and they were beveled off on the anterior surface, leaving a free bleeding surface of cancellous bone.

2. Semi-elliptical incision over left tibia. A piece of bone including its periosteum 1 inch by $3\frac{1}{4}$ inches was removed from the anterior surface. This extended down to the medullary canal which in this particular tibia was about 0.5 cm. from the anterior surface. The muscles were sutured over the tibia and the skin and subcutaneous tissue closed with silkworm and silk.

Gloves and instruments used in this procedure were then discarded. Piece removed was split longitudinally so that it consisted of two pieces, was then fixed to the symphysis bridging the defect, and held in place by chromic sutures, inserted through drill holes in the transplant and symphysis

FRACTURE-DISLOCATION OF THE CERVICAL SPINE

Fat and connective tissue were united around the transplant as well as possible and the wound closed with silkworm gut and silk. The pelvis was immobilized as far as possible by a mole-skin plaster and plaster-of-Paris girdle extending from about a little above the umbilicus to below the femoral trochanters. Gas and ether. Duration of operation, one hour and fifty-three minutes. Condition good.

September 12, 1922, she was readmitted on account of a complete procidentia of the uterus with rectocele and cystocele—triangular ligament almost completely gone. The old graft in the pubis seems slightly movable at one end. Levator ani muscles retracted and much atrophied. Moderate discharge. Patient walked with a distinct "waddle gait." A distinct separation could be felt by manual examination between the two pubic bones.

September 20, 1922, Doctor Bancroft submitted her to vaginal hysterectomy and perineorrhaphy.

This case was presented because the X-rays show the persistence of the bone graft two and one-half years following operation. While there has been separation at one junction to the symphysis, this is so fixed with fibrous tissue that there is practically no free motion, and the patient is now able to walk without the waddling gait, which originally tended to interfere with walking. Also it is interesting to note that the wide separation of the symphysis probably caused a tear in the pelvic fascia. As a result of this a complete prolapse occurred.

LACERATED FLEXOR TENDONS, MEDIAN AND ULNAR NERVES

DR. FREDERIC W. BANCROFT presented a man sixty-four years of age who came to the hospital on December 8, 1922 suffering from laceration of tendons of wrist (left) with laceration of the ulnar and median nerves. Patient was walking down stairs and slipped, falling through a window glass. He threw his arm up to save himself and was cut across the wrist. Patient was conscious throughout accident. There was loss of function of all the fingers, no flexor-profundus or flexor sublimis function. There was loss of sensation over the distribution of the ulnar and median nerves.

On the following day Doctor Bancroft enlarged upwards at the ulnar border the incision which lay diagonally across the wrist on the ventral surface. The sublimis and profundus tendons had been cut. These were isolated and identified as far as possible. The median nerve was dissected up, isolated and sutured by three stay sutures through the neurilemma and then a fine continuous suture. The ulnar nerve was repaired in a similar manner. The profundus and sublimis tendons were then repaired as accurately as possible, but it was felt that possibly two tendons were not sutured correctly, but as the patient was an old man and the operative procedure had already lasted one and one-half hours, it was considered inadvisable to prolong it any further. The palmaris longus tendon was also sutured. The anterior annular ligament was closed with chromic and the skin with silk. The hand was put up in acute flexion.

Following the operation the patient had trophic ulcers at the tips of his fingers. He has been treated with baking and massage. At the present time he has no loss of sensation in the hand and motion at the wrist is normal. There is some atrophy of the interossei and some slight limitation of flexion.

FRACTURE-DISLOCATION OF THE CERVICAL SPINE

DR. ALFRED S. TAYLOR presented a man, twenty-seven years of age who had had recurrent dislocations of left shoulder and both patellae. On

February 23, 1920, while wrestling he fell to the floor powerless; with pain in neck, especially on movement.

February 28, when examined, both upper extremities were partly paralyzed, and showed hypæsthesia in the musculospiral distribution. No loss of power in lower extremities, sphincters, or trunk. The only sensory disturbance (except above) was that below dorsal ii; both hot and cold were called hot. Reflexes: absent in upper extremities, abdomen and cremaster muscles; knee jerks slightly exaggerated; abdominal reflexes normal; no Babinski. Rapidly exhaustible ankle clonus on left side.

Flexion of the neck and rotation of the head to either side, whether active or passive, caused pain. Marked tenderness to pressure over the lower cervical spine both anterior and posterior, and deformity posteriorly.

Radiograph: showed fracture-dislocation of cervical v on cervical vi.

March 3, 1920 (eight days after injury) reduction was accomplished, without anæsthesia, by the method described below. Immediate relief of pains and discomforts followed.

A plaster-of-Paris jacket was applied. Radiographs two days later showed good condition. After two weeks a reinforced leather collar and breast-plate replaced the plaster jacket and he returned home.

March 23, due to misunderstanding he had removed the leather support several times. A radiograph showed partial recurrence.

March 26, a second reduction with plaster jacket fixation. A couple of weeks later a steel spinal brace with jury-mast to extend the head and neck was applied.

June 19, 1920, Radiograph showed a slight recurrence.

June 24, under local anæsthesia, open reduction was attempted but was only partially successful. Heavy silk sutures around the spinous processes were used to retain the best obtainable reduction.

At intervals radiographs were taken to show if bony union were occurring between cervical v and cervical vi. In March, 1921, union was sufficient to allow removal of brace.

There has been perfect recovery of function with solid union of cervical v and cervical vi.

DOCTOR TAYLOR presented a second case, a woman thirty-five years of age who on October 25, 1922, in an automobile accident, landed on her head and neck. Immediate total loss of function followed in trunk, sphincters and lower extremities. Partial loss in upper extremities. Very painful spasmodic contractions of the neck muscles. Twelve hours after accident, a slight return of certain reflexes and sensations below the lesion led Doctors Kennedy, Pool and himself to believe that the cord had not been completely crushed by the fracture-dislocation which had obviously occurred and was probably situated between cervical v and cervical vi.

Stereo-radiographs showed extreme forward dislocation of cervical v on cervical vi with some crushing of the bodies on the left side.

October 27, reduction under ether was accomplished. Radiograph immediately after, showed perfect alignment. A plaster jacket was applied to maintain extension and reduction.

The painful muscle spasms ceased at once. There has been a gradual return of function below the level of the lesion, somewhat irregular in distribution. Sphincteric control returned after a few weeks. At present the right upper and lower extremities move freely and with power. The left upper extremity still shows spasticity in the flexors and extensors of the fingers, but improvement is still occurring. Sensation is nearly absent in the right lower extremity, and is nearly normal in the left lower. She gets

SPLENECTOMY FOR SPLENIC ANÆMIA

about with slight assistance, can write, and attends to her duties as an executive.

February 29, 1924, sixteen months after the reduction. Solid bony union was found to have occurred between cervical v and cervical vi. It had probably occurred sooner but no radiographs had been taken for several months.

DOCTOR TAYLOR called attention to the occurrence of neck dislocation in a patient suffering recurrent dislocations in shoulder and patellæ after injuries, showing poor reparative power.

Gradual absorption of the intervertebral disc, especially its anterior portion, with some erosion of the vertebral bodies, and this in spite of the extension apparatus. Slow development of bony union between the damaged vertebræ, (about one year in each case) showing the necessity of prolonged use of support. He thought a modified application of the same method might be useful in fractures and dislocations in other portions of the spine.

DR. EUGENE H. POOL said that he remembered this case very well. Soon after the patient was admitted to the hospital she showed symmetrical bilateral sensory and motor paralysis from area of the fifth and sixth cervical segment downward: He had never seen a case with such findings where the paralysis cleared up at all. The X-ray indicated such extensive displacement that it was thought that the cord must be completely destroyed at the level of dislocation. The reduction had been done in the most well-planned, deliberate and successful manner.

DR. ROYAL WHITMAN said he had recently seen a patient after complete recovery from a fracture and dislocation of the third cervical vertebra accompanied by paralysis. In this instance the displacement, which had resisted traction, had been easily reduced by direct pressure of the finger in the pharynx.

SPLENECTOMY FOR SPLENIC ANÆMIA; CONTINUED HÆMATEMESIS DUE TO THROMBOSIS OF SPLENIC VEIN

DR. EUGENE H. POOL presented a man who in February, 1917, when he was nineteen years of age, complained of vomiting of blood and swelling of abdomen. He vomited a large amount of blood three times and was brought to hospital in an ambulance.

At twelve years of age he had a similar attack. At that time, there was a period of malaise for a week, and then he began to vomit blood. At that time, he vomited about two quarts, he thinks. Also a mass was noted in his left hypochondrium. Was ill in Mt. Sinai Hospital for five weeks. After leaving the hospital he got his strength back pretty quickly. Three months ago he vomited several ounces of blood.

On admission in 1917, there was on inspiration a projection of a definite mass in the left upper quadrant of the abdomen. The lower pole extends to the level of the umbilicus and inner margin within an inch of the midline. It moves with respiration. On palpation, this mass is firm and presents a notch on its mesial border. Liver edge not made out.

Blood Counts.—Counts made every two days showed increasing anæmia.

Date	Hgb. %	WBC	Polys. %	Lymph. %	Trans.	Eos. %	RBC
Feb. 20th	55	8000	74	24	0	1	
March 2nd	27	6800	69	22	7	2	2,600,000

Date	Anisocytosis	Poikilocytosis	Normoblast per 100 WBC
Feb. 20th	1 plus	1 plus	..
Mar. 2nd	1 plus	1 plus	1

Wassermann blood, negative.

Fragility test on red blood cells, March 3, 1917. Hæmolysis begins at 58 per cent. Hæmolysis complete at 38 per cent. Vital stain: 2.2 per cent. Basophilis stripping. Blood coagulation time, 8 minutes Duke coagulometer.

Bleeding time increased (not recorded). Stools showed blood five times. Operation, March 3, 1917 by Doctor Pool. 1. Transfusion by Lindemann method. 2. Four hundred c.c. of blood transfused. Spleen found to be enlarged; very firmly adherent; covered by omentum. The omentum was drawn mesially so as to expose the spleen. It was found to have a thick capsule and was very firmly adherent to the parietal wall at the outer and upper part. The adhesions were cut and torn with considerable bleeding until the spleen was mobilized, two towels being placed against the bleeding areas to control hemorrhage. A stomach clamp with rubber tubes was placed across the pedicle. The pedicle was ligated piece-meal and the spleen excised. The raw areas and bleeding points were then approximated by continuous stitch of catgut. Wound closed without drainage. The specimen was found to consist of a moderately enlarged, slightly deformed spleen, weighing 610 grams and measuring $18\frac{1}{2} \times 11\frac{1}{2} \times 5$ cm. The sections of the spleen showed the microscopic features of a marked grade of chronic interstitial inflammation. The trabeculæ are increased in number and in thickness. The Malpighian bodies are of varying size, some being quite small, others of normal size or larger; a few of the Malpighian bodies show a central proliferation of endothelial cells. The pulp of the organ presents everywhere considerable spaces among the meshes of the coarse reticulum in which are some blood cells and nucleated cells.

The patient when seen at intervals thereafter was generally well, except for some distress after meals and a great deal of gas. His bowels moved naturally every day.

June 21, 1923 he was admitted to St. Luke's Hospital on account of epigastric distress with belching of gas and nausea with bloody vomitus. no evidence of ulcer of stomach or duodenum. Transfusion of blood 500 c.c. was done. He left the hospital greatly improved, but was readmitted two months later, having redeveloped a severe secondary anemia, for which a renewed transfusion of 500 c.c. was done. Following his discharge from the hospital he had another hemorrhage from the stomach, suffered from indigestion and was finally re-admitted to the New York Hospital on November 26, 1923 complaining of bloody vomitus and blood in stools, with epigastric pain and some elevation of temperature.

December 3, 1923, an exploratory laparotomy was done by Doctor Pool. through a right rectus incision. The liver looked practically normal, consistency and color showing nothing unusual. A piece was removed for examination. The hand passed into the splenic region revealed a number of adhesions which indented stomach somewhat but no ulcer or neoplasm could be recognized on palpation. The lesser curvature and remainder of stomach showed nothing abnormal. The duodenum, however, presented a peculiar white thickening between duodenum and liver. The true nature of this could not be determined. The hand was passed down into the abdomen and nothing abnormal felt elsewhere. The stippling and thickening of the upper duodenal wall suggested the possibility of ulcer, therefore a transverse incision was made. Careful examination of the mucous membrane of duodenum through this orifice failed to reveal an ulcer. A piece from the margin of this was removed to determine whether there was duodenitis. The nodular, indurated tissue above the duodenum seemed to extend behind the lesser curvature; the whole corresponding somewhat to the situation of

SACRO-COCCYGEAL CHORDOMA

pancreas. A piece was removed for microscopic examination. The opening in the duodenum was now closed with two layers of chromic catgut.

The reporter thought that the tissue changes were inflammatory. The extension of the induration back of the stomach and along pancreas suggests the course of the splenic vein. It may well be that a retrograded thrombosis of the splenic vein occurred with some infection and inflammatory changes around this. This, however, seems less probable on account of the long interval since the operation of splenectomy. As to the pancreatitis the induration seemed to be rather above than in the pancreas.

Microscopic sections of liver show the liver cells with a clear cytoplasm (the normal appearance which is seen when the liver is fixed immediately after removal from a living subject). There is no increase in connective tissue. Section of mucosa from duodenum show Brunners glands covered by a thin atrophic mucosa. Section of thickened area on duodenal wall shows adipose tissue divided up with bands of mature fibrous connective tissue. Several large blood-vessels are cut in transverse section and show thickening of wall and partial obliteration with what is apparently an organized canalized thrombus.

BLOOD COUNT

Date	Hgb. %	WBC	Polys. %	Lymph. %	Mono. %	Trans. %	Eos. %	RBC
Nov. 26	60	7550	64	26	6	2	2	3,550,000
Dec. 20	50	10200	66					3 912,000

SACRO-COCCYGEAL CHORDOMA

DR. EUGENE H. POOL presented a woman whose previous history is given in *ANNALS OF SURGERY*, 1922, vol. lxxvi, p. 123. The case was then presented before this Society as a rarity. It is now shown two and one-half years after operation to record the late result. According to N. D. C. Lewis (*Arch of Int. Medicine*, 1921, vol. xxviii, p. 434) these tumors rarely give rise to metastases, but infiltrate widely and have proved 100 per cent. fatal. An incomplete operation was performed, removing soft tumor tissue through an opening in dorsum of sacrum. Radium was subsequently applied through this opening at the General Memorial Hospital. She was recently admitted for observation: complete fluoroscopic and physical examination failed to reveal any metastases. The sacrum was opened dorsally and the interior of the mass was found bony hard. There was no soft tumor tissue. Specimens removed failed to reveal tumor microscopically. Cystoscopic and rectal examinations were negative, except the original bony projection in the hollow of sacrum. As far as can be determined there is no extension of the growth more than two and one-half years since the palliative operation. It is of interest as offering encouragement for radium treatment in similar cases. This type of tumor seems peculiarly favorable to radium treatment, since it is generally stated that it does not metastasize and the tumor gives the impression of low vitality, consisting of a slowly growing mass of syncytial tissue.

The following notes of the treatment given at the Memorial Hospital, complete the record of the case.

May 6, 1921, X-ray treatment 15 minutes to sacrum, May 13, 1921, 15 minutes to pubis. July 3, 1921, tubes of radium emanation with silver filtration were placed in the sacral wound, 456 mc. hours being given. August 1, 1921, tumor of sacrum showed marked regression. Patient has complained of some low abdominal pain during past two weeks. August 9, 1921, discharged—improved. August 23, 1921, on rectal examination the tumor in sacrum seemed much smaller and more nodular than it was several

months ago. The external lesion in anal crease appears to be healing. September 13, 1921, sacral wound nearly healed. Still a sinus at its bottom leading apparently directly into sacrum. Rectal examination same. X-ray treatment, October 4, 1921, 15 minutes to sacrum; October 11, 1921, 15 minutes to pubis. Examination in X-ray Department, December 28, 1921, patient complains of severe pains in pelvis. To receive further X-ray treatment. X-ray treatment, January 6, 1922, 15 minutes to pelvis posteriorly over sacrum. March 29, 1922 patient had severe pain and has difficulty in defecation. April 14, 1922, she was given a 20 minute treatment over pelvis with X-ray.

October 29, 1923, the superficial nodes are not particularly marked in any group and not suggestive of secondary growths. Fluoroscopic examination of the general skeleton shows no areas that are suggestive of new growths.

DR. JOHN F. ERDMANN asked if there had been any suspicion of this chordoma being a variety of sarcoma. He had had three cases, two in which the tumor had been regarded as sarcoma and the third unknown. The first one he removed some years ago and the patient lived for one and one-half years before expiring. He did not know what became of the second case. The third was a young man also, (all the patients were males,) who was operated on one and one-half years ago and radium was used and he is now in excellent condition. He gained thirty pounds in weight after the operation.

DOCTOR POOL replied that the pathologists reported the tumor was a typical chordoma with characteristic syncytial tissue. There was nothing to suggest it was a sarcoma.

HÆMOLYTIC JAUNDICE IN A CHILD OF FOUR YEARS

DR. A. O. WHIPPLE presented a child aged four years, who three weeks before admission, developed a sore throat with a little fever every night. This lasted for two weeks. One week before admission she vomited yellow fluid with a little blood. Her mother noticed that the skin and eyes were yellow and urine was dark. The child was a seven months baby, which only weighed two and one-half pounds at birth. Always small and underweight. The father had had attacks of jaundice every year since he was six years old. Was diagnosed acquired hæmolytic jaundice one year ago and spleen removed by Doctor Whipple.

The patient was an underdeveloped girl of four years, pale, skin yellow, scleræ yellow. Tonsils large and cryptic. Liver palpable two fingers breadth below costal margin. Spleen sharp, hard, non-tender edge palpable two fingers breadth below costal margin.

Laboratory findings: White blood cells, 13,400; polymorphonuclears, 63 per cent.; red blood cells, 4,320,000. Fragility test was strong through .45 and partial through .55—slight at .60 as opposed to control which stopped at .45. Urine urobilin, 720-800. Dilution units. Stool 4500 dilution units of urobilin as opposed to normal 450. Wassermann negative cholesterol. Red blood cells 5 per cent. reticulated.

While in the hospital the jaundice cleared up except for slight suggestion of yellow in the scleræ. The liver and spleen have remained unchanged. At conference it was decided to wait and follow the case and operate only if patient began showing increased destruction of red blood corpuscles.

Final diagnosis, congenital hæmolytic jaundice. Discharged, home improved.

SUBPHRENIC ABSCESS AND ACCUMULATIONS OF FLUID

DR. JOHN F. ERDMANN said that he had during the past week had two cases of hæmolytic jaundice, brothers, one a boy of $4\frac{2}{12}$ years and the other $6\frac{1}{2}$ years of age. He had removed their spleens. They were the children of a mother who had her spleen removed for familial jaundice. The pathologist reported they were absolutely hæmolytic spleens from the blood picture. He had another case of a child of thirteen who was doing very well. He considered one was justified in going ahead and removing the spleen with the evidence presented by these blood changes.

SUBPHRENIC ABSCESS AND ACCUMULATIONS OF FLUID

DR. JOHN DOUGLAS read a paper with the above title for which see vol. lxxix, page 845.

DR. FRANK S. MATHEWS said that Doctor Douglas' paper would emphasize the fact that the diagnosis of subphrenic abscess in its early days is not always found easy even by competent physicians and surgeons. Most of the cases presented have come to operation after the abscess has reached considerable size. Doctor Mathews' last case of subphrenic abscess was operated on through a gall-bladder incision under the impression that the case was one of acute gall-bladder disease. The abscess had extended over the surface of the liver and involved the fundus of the gall-bladder. It was probably secondary to a duodenal ulcer. It is his impression that gall-bladder disease, though not infrequently associated with liver infections, is a surprisingly infrequent cause of subphrenic abscess.

Doctor Douglas has reported a case of the speaker which was sent to the hospital as an empyema. Two things which cast doubt upon this diagnosis were, first, that the pus removed by aspiration had had an odor suggesting the colon bacillus, and, second, that there was a fulness and tenderness under the origin of the right rectus muscle. The diagnosis was cleared up by an X-ray which showed a bubble of gas under the diaphragm.

DR. ALLEN O. WHIPPLE gave a brief summary of the cases of subphrenic abscess at the Presbyterian Hospital during the past ten years. There were twenty in all. Four followed acute appendicitis, 5 acute cholecystitis, 2 followed ulcer, 3 were associated with pneumococcus bacteræmia, 1 was associated with empyema, 1 followed lung abscess, 2 followed perinephritic abscess, and 2 followed pelvic disease. Bacterial examination showed streptococcus in 5, staphylococcus in 2, pneumococcus in 2, mixed culture in 5, only 14 out of the 20 being cultured. There were 6 deaths, one of the appendicitis cases, one gall-bladder case, 2 ulcer cases, one pneumonia case, and one of the cases of pelvic disease.

A point, in addition to the importance of the X-ray as an aid in the therapy of this complication, which Doctor Whipple wished to emphasize was the importance of not making too early an attempt to drain these collections. The tendency, with an early diagnosis, is to explore as soon as the high diaphragm is detected. This is a mistake. The fluid should be allowed to

become localized and needless trauma can thus be avoided as illustrated in a number of cases of this series that had become well localized after drainage and gave an exceedingly good result.

DOCTOR DOUGLAS, in closing the discussion, said that in his paper his main point was to emphasize that there had been a tendency in nearly all these cases to misinterpret the physical signs over the base of the lung as a chest lesion, and not to give due consideration to the history and physical signs which pointed to a pathological condition within the abdomen. He also called attention to the importance of the X-ray finding of air and a fluid level below a high and fixed diaphragm, and the necessity of making the X-ray examination with the patient in a position which will allow the air to rise to the highest point.

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THE INDUCTION OF SPLANCHNIC ANALGESIA FROM A CLINICAL AND ANATOMICAL STANDPOINT

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IT CANNOT be proven by statistics that major abdominal operations performed under general narcosis are associated with greater dangers than when regional anæsthesia is utilized; nor can it be statistically determined whether or not the induction of regional anæsthesia involves greater risks than the administration of ether narcosis. It is a matter of opinion based on more or less justifiable attitudes and the personal equation of the operator plays a very important part in the achievement of the end-results. But it is well established that local anæsthetics, *when used judiciously*, limit their field of action to the anæsthetized area and leave practically undisturbed the functional activities of the organs on which life chiefly depends. That post-operative disturbances, which are mostly post-anæsthetic, are considerably minimized, morbidity and mortality greatly reduced when regional anæsthesia is the method employed, cannot be honestly denied. That there are cases in which general narcosis should absolutely be avoided is most certain, whatever be the attitude of the profession to the question of regional anæsthesia or general narcosis in abdominal surgery. It is chiefly on behalf of the bad-risk patients that splanchnic analgesia has been devised.

Review of Literature.—More than twenty-five years ago the first laparotomies for gastrostomy and gastro-enterostomy were performed under local anæsthesia. Local infiltration according to the method of Reclus or Schleich was the procedure used for anæsthetizing the abdominal wall. Manipulation of the deeper structures was rendered possible only by the administration of general narcosis; and this combined anæsthesia was, for a long time, considered the method of choice.

Braun's² method of anæsthetizing the abdominal wall was the first step toward widening the scope of local anæsthesia in major abdominal surgery. It gave a wider field of anæsthesia and better exposure of the viscera, as a result of considerable muscular relaxation.

Finsterer's^{5, 6} "Mesenterial anæsthesia" mentioned at the German Congress of Scientists in 1912, was sufficient in a fairly good number of gastric operations, but failed to give satisfaction in extensive resections of the stomach which had to be completed under general narcosis.

Kappis'¹² method of inducing paravertebral anæsthesia was the next important development. It was based on the assumption that the sympathetic system was res-

possible for pain perception in the abdominal cavity and that the rami-communicantes transmitted the painful impulses to the central nervous system. Paravertebral anaesthesia of the upper abdominal organs was, however, abandoned by its author as soon as splanchnic analgesia was made possible by easier and quicker procedures.

In the winter of 1913-1914, Kappis^{14, 15} began to induce regional anaesthesia for abdominal operations by local anaesthetization of the abdominal wall and injection of the area supplied by the splanchnic nerves and of the lumbar rami-communicantes (L¹ to L³) proceeding from the dorsal aspect of the body. The first announcement of splanchnic analgesia was made by him at the German Surgical Congress of 1914.

In 1917, Wendling^{43, 44} described a method of his own by which the area supplied by the splanchnic nerves was reached at the level of the coeliac plexus, the needle being introduced through the anterior abdominal wall, the left lobe of the liver and lesser omentum until its point came in contact with the vertebral column.

The year after (1918), Kappis¹⁵ reported 200 operations, mostly stomach and gall-bladder, the majority of which had been performed since the early part of 1917.

The fifth edition of Braun's book (1919),² contains a description of its author's method of inducing local anaesthesia for gastric operations, by injecting the anaesthetic solution on both sides of the vertebral column through a point of entrance between the aorta and vena cava at the level of the first lumbar vertebra just above the pancreas; the injections being made after laparotomy.

In 1919, Naegeli^{29, 30} used the posterior route of Kappis with a modified technic and published the results of his experiences with splanchnic analgesia which included 18 cases mostly stomach. Buhre³ described the procedure devised by Braun and reported 33 cases of splanchnic analgesia induced after opening the abdominal cavity. Pauchet³⁵ used the same procedure. Denk⁴ published his results with Kappis' technic. Preiss and Ritter^{37, 38} reported 89 cases of splanchnic anaesthesia in 15 different types of operations (abdominal and renal). At the French Congress of Surgery held in Paris the same year. Mare Roussiel⁴⁰ announced that the method he used consisted in the injection of D¹⁰ and D¹¹ or D¹¹ and D¹², which was a true blocking of the splanchnic nerves, and that the anaesthesia thus produced was sufficient for all gastric operations.

In 1920, I²² reported the first 12 operations performed in France under splanchnic analgesia according to Naegeli's technic which is a modification of Kappis', and introduced the method in this country.³ The year after I published in England the results of my experience with 34 major abdominal operations also performed in France (Pauchet's Clinic, Paris) with the same technic. Hoffmann,⁹ Khautz,¹⁹ Paul³⁶ and others also contributed to the literature on the subject.

In 1922, Mirizzi²⁵ reported 26 cases with Kappis' method and 3 cases with Braun's method. Gandusio and Pototsehnig⁷ used Kappis' method in 18 cases; Quarella³⁹ in 12 cases.

Last year Metge²⁷ reported 112 operations following Kappis' technic exactly. Hustinx¹¹ added 119 cases to those already on record using Braun's technic as well as Kappis'. Finsterer reported, in one of his lectures at University and Bellevue Hospital Medical College, N. Y., 566 gastric resections performed under splanchnic anaesthesia according to Braun's technic. As far as I know this is the largest series.

Since my last publication in the *British Journal of Surgery* I have added a few more cases to my credit. The two gastric resections reported in this paper are among my latest demonstrations of splanchnic analgesia in major abdominal surgery. I am greatly indebted to Drs. Charles W. Walker and Louis F. Lange for their patients' histories and personal post-operative observations.

Abdominal Sensibility to Pain.—Our present knowledge of the transmission of painful stimuli from the abdominal cavity and viscera to the central nervous system is largely due to Neumann^{31, 32, 33} and Kappis,^{13, 16} who arrived at practically the same conclusions based on animal experimentation.

Until the year 1911, nothing definite had been published on the sensibility of the abdominal organs and Lennander's^{25, 26} opinion was still prevailing among the great majority of surgeons, *vis.*, that the viscera are insensitive and that the parietal peritoneum is the only pain-receptive structure of the abdominal cavity. Clinical observers were and are still agreed that the viscera are insensitive to painful stimuli, and that pain commences as soon as tractions are exerted on the viscera or their pedicles. Exploratory manœuvres during which the bowels are displaced are also associated with pain whose intensity varies with the susceptibility of the patient and the nature of the manipulations.

In the summer of 1912, Kappis,^{13, 16} conducted a number of experiments on the dog with a view to answering the question of sensibility of the abdominal organs. His findings were that sensory nerves accompany the blood-vessels going to the viscera, but that their number is relatively small considering the extensive territory which they supply; for this reason the nerves lose their power of transmitting

pain before they enter the organs. "It may be," says Kappis, "that the pain transmitting fibres cease before the entrance of the nerves into the organs. It may be that they are not in sufficient number and strength to allow perception of the sense of pain. At any rate the abdominal viscera may be regarded as practically without sensation. But this does not say that the visceral peritoneum and its contents lack every power of pain perception. On the contrary, at those points where nerves are present in sufficient number and strength, and that is practically speaking the larger, medium, or at least not the very small vessels, a distinct pain perception may be proved to exist under all forms of stimulation.

On account of this in the visceral peritoneum of the dog, those parts are pain-perceptive or at least not insensitive under proper stimuli which carry the larger nerves and vessels; in other words the blood-vessel-carrying portion

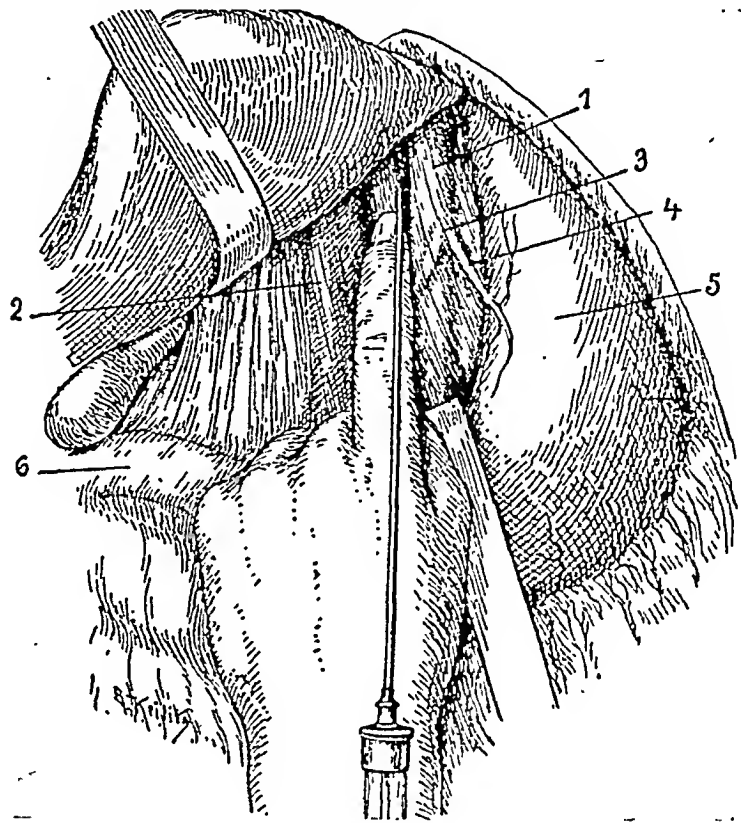


FIG. 1.—Splanchnic analgesia by the anterior route. (Braun *in* Finsterer.) Left lobe of liver retracted upward, stomach drawn down, through which the small omentum is stretched. 1, aorta; 2, vena cava; 3, coeliac axis; 4, arteria gastrica sinistra; 5, stomach; 6, duodenum.

of the mesentery, the small omentum, the attachment of the greater omentum to the stomach and naturally the great vessels themselves". Neumann,¹¹ Kappis¹³ and Hoffmann¹⁰ found that in dogs section of the splanchnic nerves abolished pain in the stomach, intestines and bile-ducts.

In 1913, on the strength of these findings, Kappis began to induce regional anæsthesia for abdominal operations by injecting the splanchnic nerves as they enter the semilunar ganglia. His results aroused the interest of the other men already engaged in abdominal surgery under regional anæsthesia

and suggested other means of approach to the splanchnic nerves and their collaterals.

Methods of Inducing Splanchnic Analgesia.—

There are three methods of inducing splanchnic analgesia: (a) Kappis',^{15, 16, 17, 18} (b) Braun's,² and (c) Wendling's;^{41, 44} but there are only two routes of approach, *viz.*, posterior and anterior. These methods aim at depositing the solution in close proximity to the splanchnic nerves soon after their passage from the thorax into the abdominal cavity, at the point where they reach the semilunar ganglia.

Kappis uses the poster-

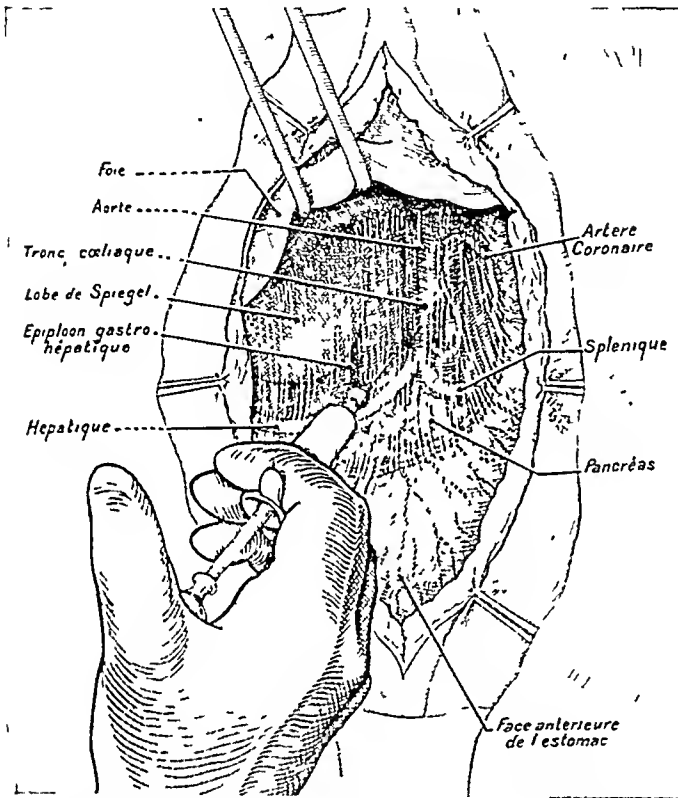


FIG. 2.—Surgical anesthesia of the solar plexus. The liver is retracted upward, the upper margin of the pancreas is defined by palpation which at the same time locates the aorta by its beats, the needle is introduced to the right of the aorta and injection is made of 20 c.c. of 1 per cent solution of neocaine (Pauchet)

rior route of approach on both sides of the vertebral column; Braun and Wendling proceed from the front. While Wendling attempts to reach the region without opening the abdominal cavity, Braun exposes the field of injection by a median laparotomy.

Kappis introduces his needle on the lower border of the 12th rib, at a point 7 cm. distant from the middle line of the back, in a direction ventralward making an angle of 30 degrees with the median plane of the body and injects the solution as soon as the point of the needle has reached the union of the lateral and anterior surfaces of the body of the vertebra. Other injections are also made up and down the side of the vertebral column "in order to make sure to reach the area at which the splanchnic nerves enter the abdominal cavity as well as their ramifications".

SPLANCHNIC ANÆSTHESIA



FIG. 3.—The lesser abdominal cavity. Stomach resected between pyloric end and a line passing a few centimetres below the cardia. Peritoneum and nerve plexuses removed leaving the semilunar ganglia on each side of the coeliac axis. Blood-vessels, crura of the diaphragm, pancreas and parietal attachment of the transverse mesocolon exposed after large resection of both costal margins and retraction of the left lobe of the liver upward.

Braun opens the abdomen on the middle line, retracts the left lobe of the liver upward, pulls the stomach downward and a little to the left, locates the aorta above the pancreas and injects the retroperitoneal tissue between the aorta and the vena cava after pushing the aorta to the left with his palpating finger.

Wendling introduces his needle to the left of the tip of the xiphisternum and attempts to reach Braun's site of injection by transfixing the left lobe of the liver and the lesser omentum.

Of these three methods, Wendling's has been discarded—I should say not even attempted on patients—because of its dangers. It has been repeatedly tried on the cadaver and found to be very unsafe, to say the least, considering the anatomy of the region. To be convinced of the merits of Wendling's method one should read Kotzareff's²⁰ comments following Sourdat's⁴² publication on the subject.

Braun's method is safer and simpler than Wendling's, since the injection is made after opening the abdomen and under the control of a guiding finger and the eye sometimes. But the manœuvres associated with this procedure are painful, *viz.*, raising the left lobe of the liver, pulling the stomach, palpating and retracting the aorta. Certain patients cannot stand them unless they be placed in a condition of twilight sleep by heavy doses of morphin and scopolamin. A contracted, highly situated, large or adherent stomach is much in the way and renders the technic absolutely impracticable. A right paramedian laparotomy is out of line with the site of injection and precludes the use of the method. A left rectus incision makes the retraction of the liver very difficult and rather insufficient.

Mirizzi²⁸ found that the injection of the splanchnic nerves according to Braun's method was always followed by infiltration of the desired area in the cadaver, but when applied to patients the result was satisfactory in only one case out of three. Even under favorable conditions failures are actually experienced with Braun's method which involves not only the difficulty of differentiating the beats of the aorta from those of the coeliac axis, but the possibility of puncturing the largest veins, *viz.*, vena cava and vena porta (Fig. 3) in which case Finsterer advises against further attempts to inject.

Kappis' method is applicable to any case, whatever be the type of laparotomy and the pathological condition of the upper abdomen. Modifications based on individual experience have been described (Naegeli,^{29, 30} Labat^{22, 23, 24}), their main object being to strengthen the weak points of the originator's technic and raise the danger signal at the approach of inexperienced hands. Thus in changing the angle advised by Kappis from 30 degrees to 45 degrees we have cautioned against passing the needle too far away from the vertebral column into the important neighboring structures; in mentioning and illustrating the level at which the needle first takes contact with the vertebral column we call attention to the intervertebral foramen which must be left behind (Fig. 4). It is obvious that if the needle were introduced carelessly at an angle less than 30 degrees it would leave the paraspinal muscular struct-

SPLANCHNIC ANÆSTHESIA

ures, pass through the fatty capsule of the kidney and puncture the renal pedicle, or not infrequently transfix the kidney, as shown by some of my cross sections. The needle would likewise come in contact with the left renal vein (Billet and Laborde,¹ Quarella³⁰), the vena cava or the aorta were it introduced deep enough.

On the other hand, if the angle of 45 degrees which the needle makes with the sagittal plane of the body in its first thrust through the soft structures of the

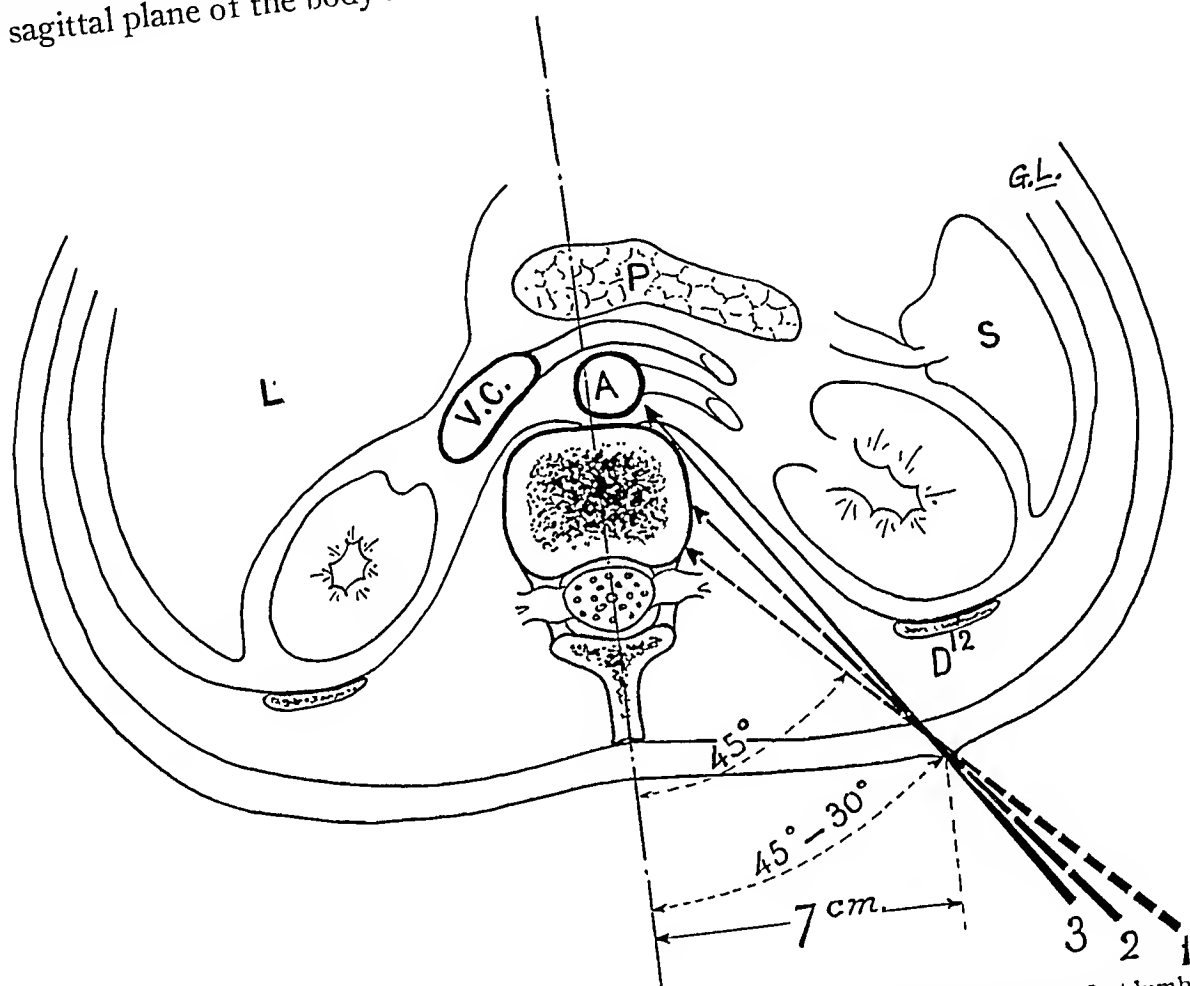


FIG. 4.—Diagrammatic illustration of a cross-section of the body passing through the first lumbar vertebra at the level of puncture and injection. Arrows 1, 2 and 3 give in succession the manner of reaching the solar plexus with safety.

back were increased to any extent, the point of the needle would occasionally reach the intervertebral foramen which is the only dangerous point backward. It would then either enter the spinal canal or induce paræsthesias before entering it. But the second step of our technic would correct the error of direction, since the needle must be partially withdrawn and reintroduced at a smaller angle until its point is felt gliding along the body of the vertebra. There is therefore no risk of making an intraspinal injection, so long as the angle at the time of injection is less than 45 degrees, no more bone felt in front of the needle, the point of the needle 10 to 12 cm. deep and no paræsthesias induced at that depth. During the whole procedure the needle must be kept strictly in the transverse plane of the body passing through the site of puncture.

To inject intraspinally or throw the anæsthetic solution into the blood stream, one must either experiment on patients without having carefully studied the method and familiarized himself with its attendant circumstances or use very poor technic.

Judging from the literature and according to my experience. Kappis'

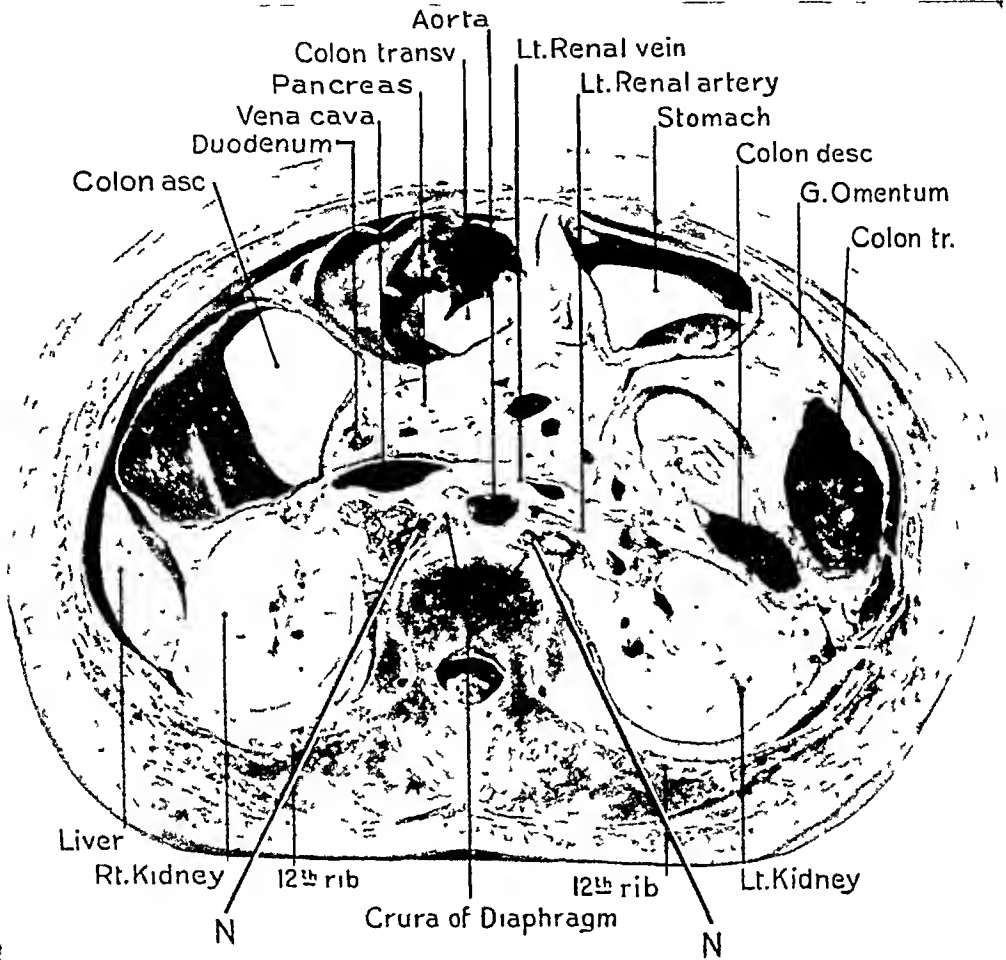


FIG. 5 —Cross section of female body (upper segment) through the usual sites of puncture on the lower border of the 12th rib 7 cm. distant from the middle line of the back, illustrating the zones of infiltration of miniam-starch (40 c.c. on each side) injected immediately before embalming with formalin. The section passed through the lower part of the body of L¹ and just above its spinous process. Formalin caused a contraction of the soft parts with consequent reduction of the costo-vertebral angle, thus altering the relation of the site of puncture to the 12th rib. Note the left renal pedicle at that level.

posterior route is the simplest and safest route of approach to the splanchnic area, whatever be the attitude of those who are afraid of inserting a needle through the musculature of the back, but boldly seek in the highly vascular territory of the lesser cavity (Fig. 3) a safe passage for the needle and the correct spot at which the anæsthetic solution must be deposited. Of course, the induction of splanchnic analgesia is a major procedure which requires skill and experience, just the same as gastrectomy, mostly for which it is given, is a major operation which the novice does not tackle with impunity. But in the hands of men already familiar with regional anæsthesia the injection

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of the splanchnic nerves by the posterior route is as safe as a paravertebral block.

I have repeatedly made injections of methylene blue in the cadaver and have never found the solution in one of the blood-vessels of the region. Safety is greater in the living being, because one can tell at any time whether or not a blood-vessel has been punctured. I have injected minium-starch in cadavers before embalming them and made cross-sections two or three weeks

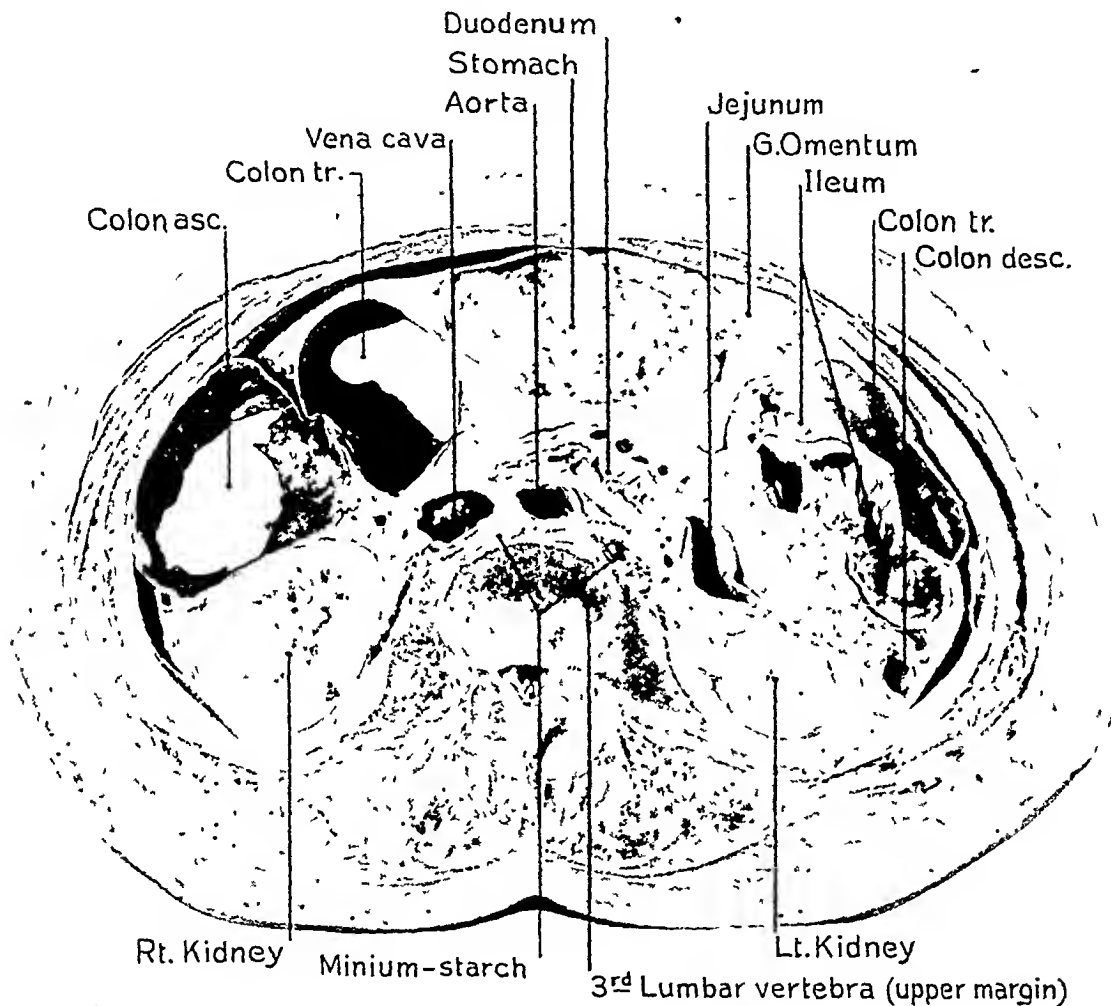


FIG. 6.—Cross-section (upper segment) of the same body as Fig. 3 passing through the upper margin of the body of L^3 showing very little of the injected minium-starch at that level, which is a proof that the bulk of the solution stays over L^1 and L^2 .

later. The disposition of the starch in these sections is very instructive and conclusive (Figs. 5 and 6). On the right side the vena cava is pushed forward by the injected fluid which distributes itself up and down along the flank of the vertebral column and covers a space considerably greater than that occupied by the splanchnic nerves, semilunar ganglia and rami-communicantes of the first three lumbar nerves. On the left side the injected fluid did not pass in front of the aorta but nevertheless reached the goal. Methylene blue solution spreads over such an extensive area in the cadaver that one would believe it possible to attempt any major abdominal operation after making only one injection on each side of the vertebral column. In the living being the retroperitoneal tissue is loose and easily distended by the anæsthetic

solution which in the majority of cases raises the pancreas from its seat; but novocaine solutions do not seem to diffuse as rapidly and extensively in live tissues as methylene blue in the dead body. Splanchnic analgesia is applicable more to the surgery of the upper abdominal organs and kidney than to that of the other parts of the abdomen, at least as far as our present experience goes.

Contributing Factors of Success.—Successful anæsthetization of the splan-

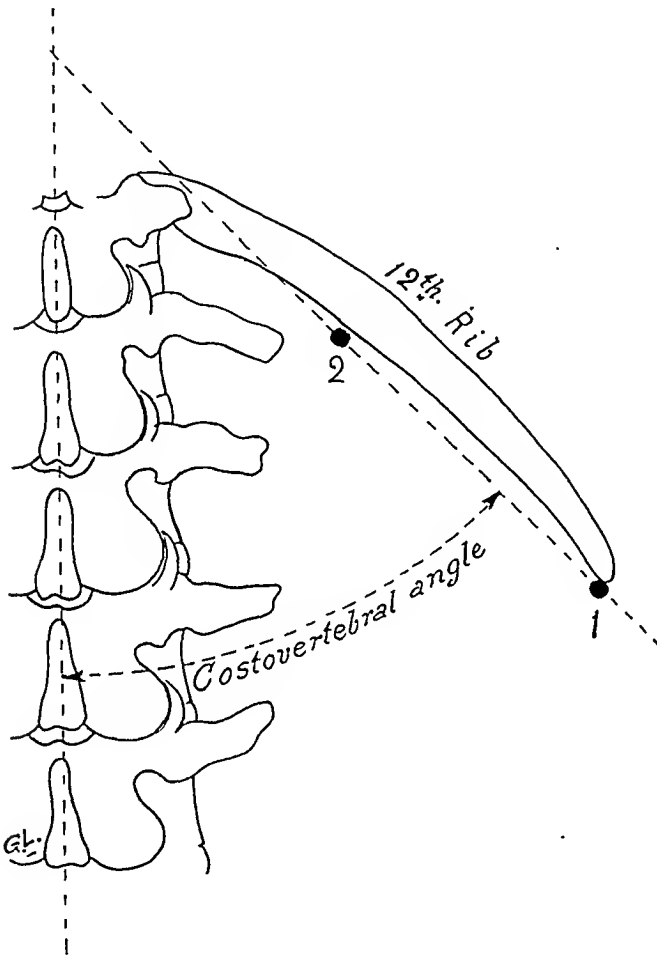


FIG. 7.—Wheals 1 and 2 are raised at the extreme palpable points of the lower border of the 12th rib which is defined by palpation from below upward and inward. The straight line passing through these two wheals marks with sufficient accuracy the direction of the 12th rib. The angle contained between this line and the middle line of the back is the costovertebral angle.

chnic nerves and their ramifications by the posterior route depends on many factors among which are: (a) general visualization of the anatomic structures of the region, from the superficial layers of the back to the constituent elements of the posterior wall of the lesser abdominal cavity; (b) tactile sense, delicate enough to transmit to the brain a fairly accurate knowledge of the structures with which the point of the needle comes in contact, in order to have a more precise visualization of the essential features closely connected with the deep landmarks; and (c) accuracy in taking the superficial landmarks. This last but not least factor we are now particularly interested in.

With the exception of Buhre's,³ not a single report hitherto published has failed to register a certain percentage of cases in which it was necessary to complete the anæsthesia by some other means (local infiltration or general narcosis); and what is more surprising is that individual technical experience does not seem to constitute an absolute guarantee against failures. Greatly interested in the cause resulting in such failures, I made a scrupulous analysis of the attendant circumstances and came to the conclusion that variations in

the anatomy of each individual were chiefly to be blamed when the injection technic was correct and the skill of the operator sufficiently great.

The ease with which the 12th rib is defined varies chiefly with the weight of the patient, the degree of relaxation of the musculature in its immediate neighborhood and the distortion of the spine due to position. The direction of the 12th rib can be accurately traced on the surface of the skin only when a sufficient length of its distal end is made salient by deep but gentle pressure applied particularly along its lower margin. The straight line

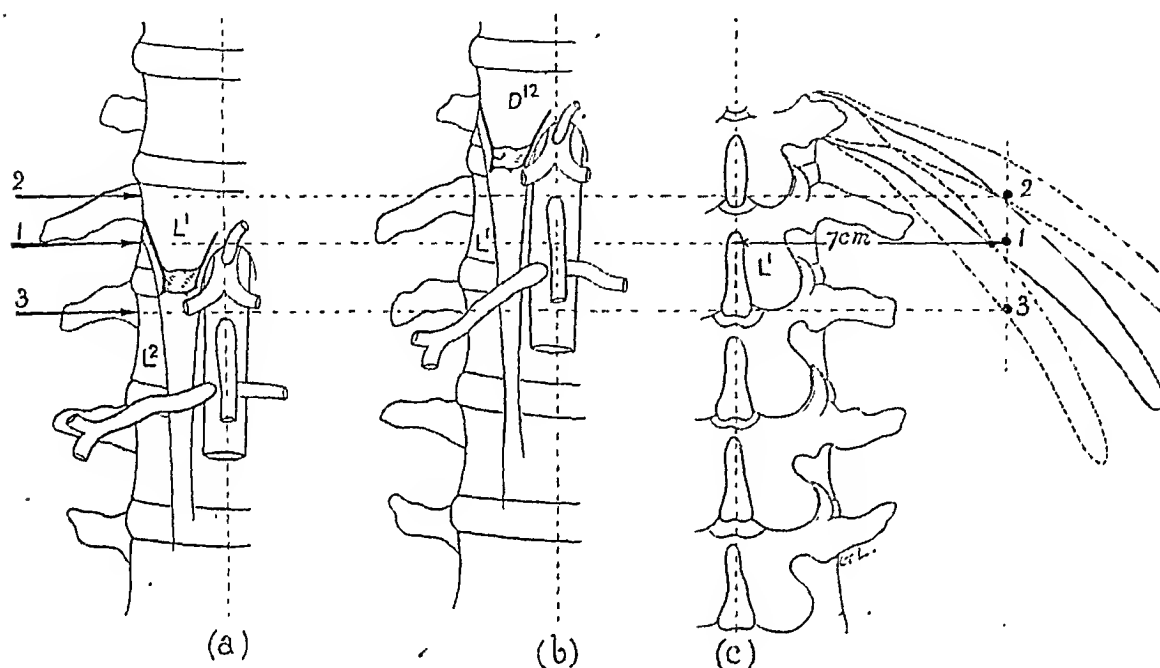


FIG. 8.—Diagrammatic illustration of actual results obtained with a constant site of puncture. While the costovertebral angle varies (c), note the levels of injection in positions (a) and (b) of the semilunar ganglia. 1, on normal rib is pretty good in (b), too high in (a). 2, on rib with costovertebral angle greater than normal is good in (b), too high in (a). 3, on rib with reduced costovertebral angle is good in (a), too low in (b).

obtained by joining the extreme palpable points (Fig. 7) may then be prolonged upward and inward, so that a point may be taken on it 7 cm. distant from the middle line of the back, according to the technic established for the posterior route.

Costovertebral Angle.—The direction which the 12th rib makes with the middle line of the back (last costovertebral angle) varies in a certain percentage of cases. Of the 52 dead bodies, mostly males, examined recently 37 presented an angle of 45 degrees and slightly greater; 10 an angle of 40 degrees; 2 an angle less than 40 degrees; 1 an angle of 55 degrees; 1 an angle of 60 degrees; 1 an angle of 70 degrees. Variations exist in both sexes, as shown by clinical observations, and they are in many instances, I believe, the cause of partial or total failure to obtain anæsthesia.

Since the distance of 7 cm. from the middle line of the back remains constant, variations in the costovertebral angle evidently result in variations in the level of the site of puncture and that of injection. Thus instead of reaching the body of the first lumbar vertebra the point of the needle glides along the body of the second lumbar vertebra if the angle is small. It stays

behind the pillars of the diaphragm if introduced at a higher level, as the result of measurements taken on a 12th rib which makes an abnormally great angle with the vertebral column (Fig. 8). It is therefore necessary to introduce in the basic principles of technic a coefficient of correction of the last costovertebral angle, so that the level of the site of injection may remain constant.

Semilunar Ganglia and Renal Pedicles.—The semilunar ganglia which are

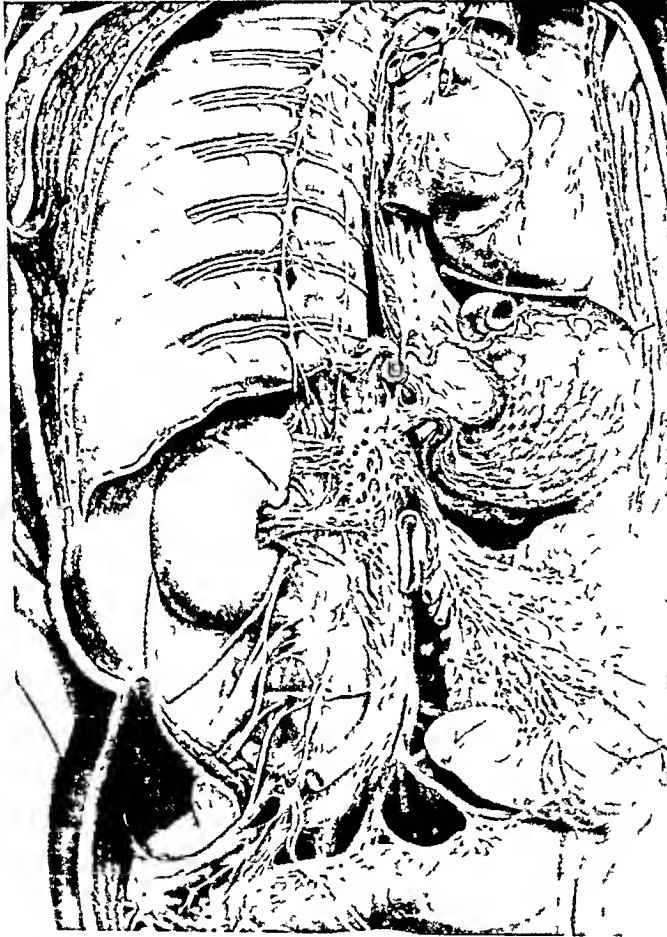


FIG. 9.—The upper abdominal sympathetic system showing the right semilunar ganglion at the lower margin of D^{12} and the right renal artery crossing the upper margin of L^1 . (Bourguery et Jacob, *Anatomie de l'Homme*.)

the targets of the needle lie either on the disk between D^{12} and L^1 , or on that uniting L^1 and L^2 from which they are separated by the crura of the diaphragm. They may rest on the upper margin of L^1 (Fig. 9) or be situated on the upper portion of L^2 . Differences of level on either side have no technical importance.

In 12 bodies examined, the right and left semilunar ganglia were found at approximately the same level on both sides. They lie on either side of the coeliac axis and, in most cases, somewhat lower than its origin but higher than that of the superior mesenteric artery. The left semilunar ganglion was more ventralward than the right which was partly hidden by the vena cava. In 3 cases the

ganglia were at the disk between D^{12} and L^1 ; in 3 cases at the upper third of L^1 ; in 1 case at the middle of L^1 ; and in 5 cases at the disk uniting L^1 and L^2 . In 1 case there were only 11 ribs present with a very short rib (2 cm. from its costotransverse articulation) attached to the vertebra below, which was the first lumbar vertebra. In this case the semilunar ganglia were at the middle third of L^1 and the renal pedicles at the disk between L^1 and L^2 (Fig. 10). There were 2 cases of very short 12th rib (5 cm. and 10 cm. measured from the middle line of the back). The former could not be palpated while the presence of the latter was revealed only by tactile

TABLE I.
Table Showing Results of Examination of Twelve Dead Bodies with Special Reference to the Levels Occupied by the Semilunar Ganglia and Renal Pedicles.

No. of dead bodies examined	12th rib			S. L. Ganglia		Costalæ Axis	Renal pedicles				Relation of site of puncture to	
	Length cm.	Angle	Pleura		Right	Left	Right		Left		Spinous process	Vertebra
			R.	L.			A.	V.	A.	V.		
1	17	45	0	4 cm.	L ¹ - L ²	L ¹ - L ²	D ¹² - L ¹	L ² - L ³	L ² - L ³	L ² - L ³ (trifle higher)	L ¹ up	L ¹ - L ²
2	20	45	7 cm.	4 cm.	L ¹ - L ²	L ¹ - L ²	L ¹ low	L ²	L ² - L ³	L ² - L ³	L ¹ up	L ¹ - L ²
3	14	45	7 cm.	5 cm.	L ¹ - L ²	L ¹ - L ²	L ¹ - L ²	L ² - L ³	L ² - L ³	L ² - L ³	L ¹ up	L ¹ - L ²
4	16	40	5 cm.	5 cm.	D ¹² - L ¹	D ¹² - L ¹	D ¹² - L ¹	L ²	L ¹ - L ² (trifle higher)	L ²	L ¹ low	L ² , low, than renal pedicles.
5	15	45	7.5 cm.	6 cm.	L ¹ up	L ¹ up	L ¹ up	L ¹ - L ²	L ¹ up	L ¹ up	L ¹ low	Body of L ²
6	18	45	9 cm.	5 cm.	L ¹ - L ²	L ¹ - L ²	L ¹ - L ²	L ² low	L ² - L ³	L ² - L ³	L ¹ low	Body of L ²
7	18	45	6 cm.	4 cm.	D ¹² - L ¹	D ¹² - L ¹	D ¹² - L ¹	L ¹ - L ²	L ¹ - L ²	L ¹ - L ²	L ¹ up	L ¹ - L ²
8*	20	55	4 cm.	0	L ¹	L ¹	L ¹	L ¹ - L ²	L ¹ - L ²	L ²	L ¹ up	Body of L ¹
9	10	60	0	0	L ¹ up	L ¹ up	L ¹ up	L ² up	L ² up	L ²	L ¹ up	L ¹ low.
10	5	70	0	0	D ¹² - L ¹	D ¹² - L ¹	D ¹² - L ¹	L ¹ - L ²	L ¹ - L ²	L ¹ - L ²	L ¹ up†	L ¹ low.
11	18	40	9 cm.	5 cm.	L ¹ - L ²	L ¹ - L ²	L ¹	L ² - L ³	L ² - L ³	L ² - L ³	L ² up	L ² low.
12	18	45	7 cm.	5 cm.	L ¹ up	L ¹ up	L ¹ up	L ² up	L ² up	L ² (trifle higher)	L ¹ up	L ¹ low.

(*) Eleven ribs only, the 12th being about 2 cm. and articulated with L¹ measurements were taken as if the 12th rib had been replaced by the 11th.
(†) Puncture made on lower border of 11th rib, the 12th rib being impalpable.
NOTE.—L¹, L², L³: first, second, third lumbar vertebra, except in column 13 where L¹, L² refer to the spinous process of the first and second lumbar vertebra; L¹-L²: disk between first and second lumbar vertebra; L¹ up: upper extremity, margin or portion of L¹; L¹ low: lower extremity, margin or portion of L¹.

sense at its distal end. The costovertebral angle measured 60 degrees and 70 degrees respectively.

The *renal pedicles* (artery and vein) generally occupied one of the two following levels: disk between L^1 and L^2 (Figs. 10 and 11); disk between L^2 and L^3 . They may have their origin slightly higher (as in Fig. 5) which is not in our series of 12, or lower than those disks, sometimes in front of the body of L^2 ; but I have never seen them beyond these extreme limits. They ordinarily slant gently downward and outward, when highly situated,

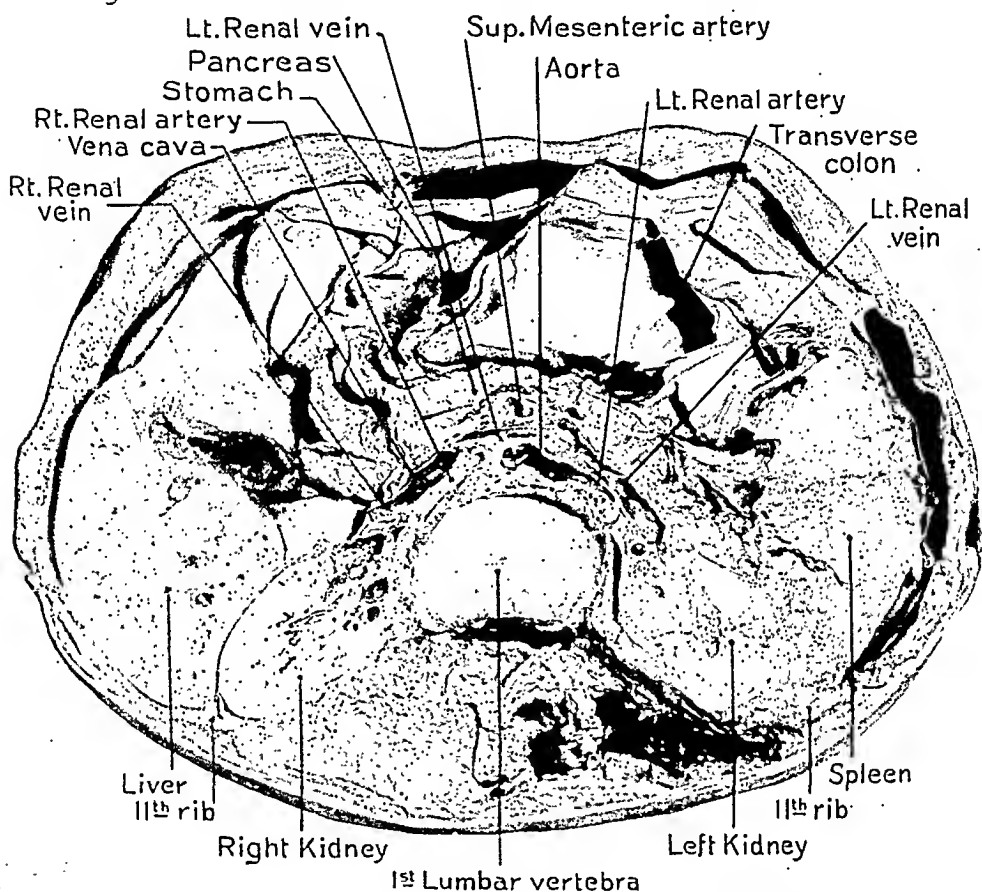


FIG. 10.—Cross-section passing through the intervertebral disk between L^1 and L^2 showing the renal pedicles at that level. This body had only 11 ribs (No. 8 of Table). The section was made through the usual site of puncture taken on the 11th rib which was thought to be the 12th.

especially on the right side. The artery is behind the vein which is a trifle higher or lower than the artery. The renal veins are very large, the left one crosses the anterior aspect of the vertebral column almost transversely. Differences of level between the two pedicles are of little significance as far as the danger of puncturing the left renal vein is concerned.

In the aforementioned series of 12 bodies (see Table I) the renal pedicles were found to be at the disk between L^1 and L^2 (Figs. 10 and 11) in 5 cases, which were those in which the semilunar ganglia were at the intervertebral disk between D^{12} and L^1 or in its immediate vicinity. These blood-vessels, especially on the left side, lay on the disk uniting L^2 and L^3 in 5 cases, and

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this was when the ganglia stood at the disk between L^1 and L^2 . They crossed L^2 in 2 cases in which the ganglia were at the upper third of L^1 .

Coefficient of Correction.—Generally speaking the semilunar ganglia occupied a high level ($D^{12} - L^1$) as many times as they were found to be low ($L^1 - L^2$), and variations in the level of the renal pedicles occurred in an equal number of cases.

If it is not wise to conclude from the examination of 12 bodies, one thing seems so far demonstrated, that is, the full height of one vertebra between

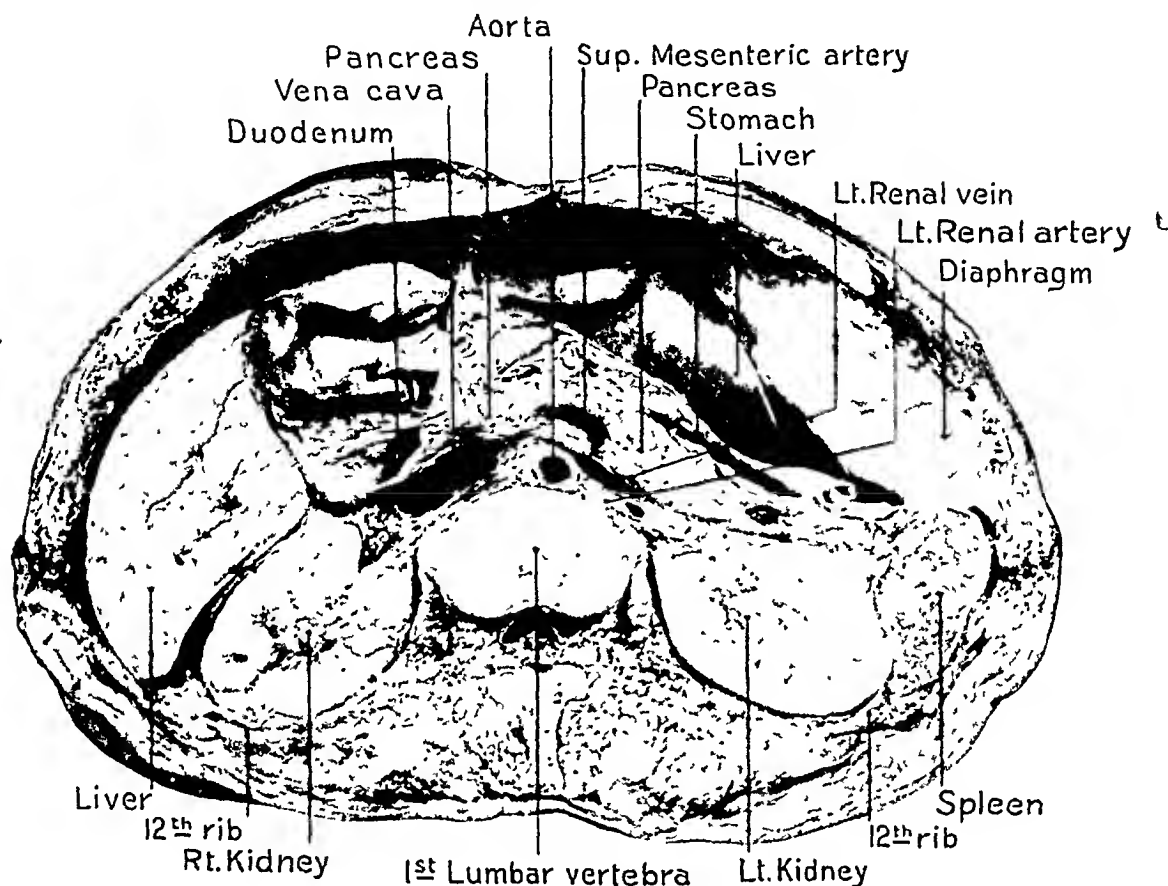


FIG. 11.—Cross-section passing through the intervertebral disk between L^1 and L^2 showing the left renal pedicle (artery and vein) and right renal artery at that level. The right renal vein was in the lower segment.

the solar ganglia and the renal pedicles. *That vertebra may be the 1st lumbar (Fig. 8, b) or the 2nd lumbar (Fig. 8, a),* irrespective of variations in the costovertebral angle. It therefore seems logical to make the injection on the flank of L^1 ; so that, if the ganglia are high situated the anæsthetic fluid will be deposited just below them, if they occupy a lower level the splanchnic nerves will be reached just as they approach the ganglia.

If the solution is deposited on the lateral aspect of L^2 , distribution takes place more along the renal pedicles, below the pancreas and toward the lower abdomen than in the direction of the semilunar ganglia; the centre of pressure of the injected fluid being too remote from its point of destination. If the needle is inserted higher than L^1 the injection is made partly behind the diaphragm and serves no purpose. It is therefore *on the lower margin of the body of the first lumbar vertebra*, that the anæsthetic fluid must be deposited in

order to produce its maximum effect, if only one injection is made on each side, as was the case in the two patients mentioned in this paper.

The body of the first lumbar vertebra can be fairly accurately determined from the surface of the skin by the relation which it bears to its own spinous process. The horizontal line passing through the upper extremity of the prominence marking the spinous process of L^1 generally passes across its body (middle or lower third). *The coefficient of correction is thus found to be the spinous process of L^1* ; if the point taken on (not below) the lower margin



FIG. 12 —Splanchnic analgesia by two injections from the same site of puncture on the lower border of the 12th rib, opposite the upper extremity of the spinous process of L^1 . (Photographed from Bourguery and Jacob, Anatomy.) The solution is deposited above and below the disk uniting L^1 and L^2 .

of the 12th rib, 7 cm. distant from the middle line of the back, is not opposite the upper extremity of L^1 owing to variations in the costo-vertebral angle, it should be raised or lowered as the case may demand. *The shaft of the needle must be kept strictly in the transverse plane of the body passing through the site of puncture.* Distortion of the spine due to position has no influence on this correction

of level. A very short impalpable 12th rib (5-6 cm.) and the presence of 11 ribs are the only abnormalities which tend to make the results somewhat doubtful.

In a certain percentage of cases, *viz.*, those in which the ganglia occupy a low level, one injection on each side of the vertebral column is not followed by complete anæsthesia. It is therefore recommended to inject in every case from 25 to 35 c.c. of the 0.5 per cent. neocaine solution at the level of L^1 and from 20 to 25 c.c. of the 0.5 per cent. of the same solution on L^2 just below the intervertebral disk between L^1 and L^2 , using the same site of puncture opposite the upper extremity of the spinous process of L^1 and giving to the needle the required direction downward (Fig. 12). The solution then distributes itself over a sufficiently wide area and not only reaches the semi-lunar ganglia wherever they may be, but soaks the spinal nerve plexuses of the posterior abdominal wall in the region exposed to direct operative manipulation.

Pleura.—The costodiaphragmatic sinuses were also examined with a view to investigating their relationship to the site of puncture and to the path of the needle, especially when there are only 11 ribs present and when the 12th rib is so short as to be misleading. The tabulated results show that in only 2 cases out of 12 did the costodiaphragmatic sinus on the right side cross the lower border of the 12th rib at a distance of 9 cm. from the middle line of

the back; its level near the spine being the transverse process of L^1 which is ordinarily just above the plane in which the needle is introduced. In body No. 8 reference is made to the 11th rib taken as the 12th rib. It was thus brought out that the needle, passed through a site of puncture on the lower border of the 12th or the 11th rib (in the absence of the 12th) and inserted in the transverse plane of the body, does not cross the costodiaphragmatic sinuses. Even if it did there would be no harm, since the solution is deposited at considerable distances from that portion of the pleural reflection. If a short 12th rib is overlooked and the puncture made with the 11th rib as landmark the needle may pass through the pleural reflection (Fig. 13), though in body No. 10 the pleura stopped higher than the transverse plane passing through the site of puncture taken on the 11th rib. It seems also that there is very little chance, if any, of traversing the costodiaphragmatic sinus on the left side. Puncturing the lung is out of the question.

Site of Injection.—

Another important factor of success is the position of the point of the needle on the lateral aspect of the vertebral column. This can be accurately determined by tactile sense as much as by the pressure needed to inject the anæsthetic fluid. When the needle has been placed correctly, its point lies in the retroperitoneal tissue whose laxity offers very little resistance to the injected fluid and the syringe is discharged as easily as in the case of a perfect caudal injection. When the syringe is disconnected in order to be refilled a few drops of the injected solution very frequently flow out of the needle, and it occasionally happens that in puncturing the opposite side the needle brings out fluid from the injected side as soon as it

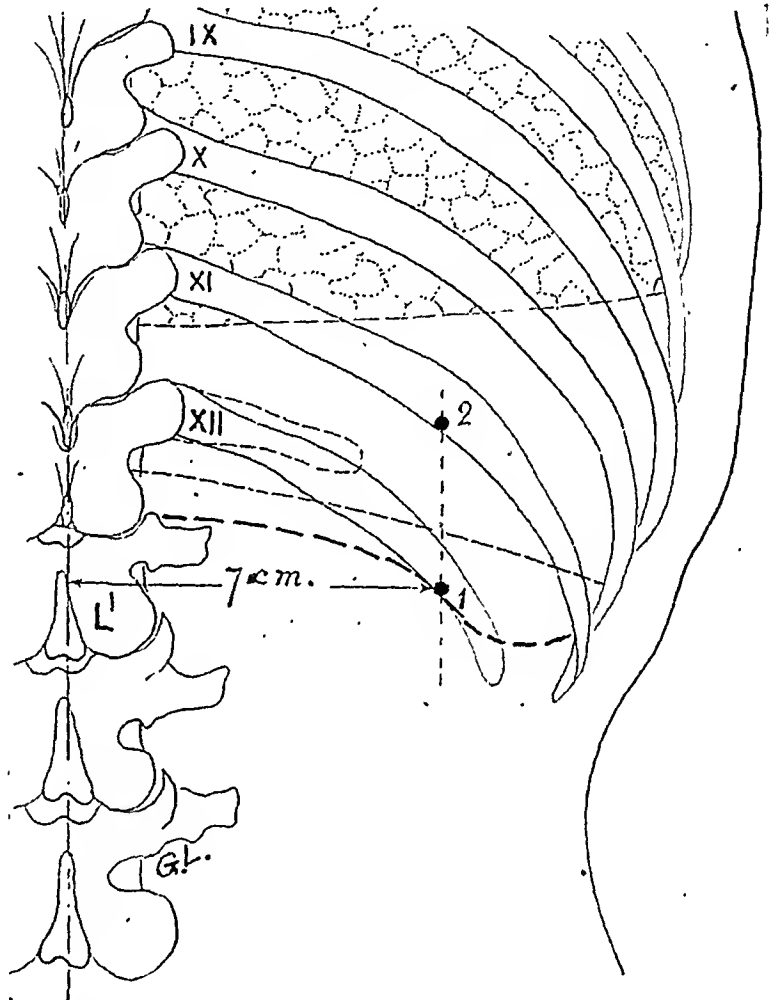


FIG. 13.—Relation of the site of puncture to the right costodiaphragmatic sinus. The needle passed through 1 is always below the pleural reflection. The heavy dotted lines show the level at which the pleura sometimes meets the lower border of the 12th rib. In a few cases the pleura follows the lower border of the rib 2 or 3 cm. further outward. Puncture through 2 is faulty technic.

has reached the correct level. Kappis advises injection at a distance of $\frac{1}{4}$ to $\frac{1}{2}$ cm. laterally to the vertebral column. This is hard to realize, especially when the most important recommendation is to keep constant contact with the body of the vertebra. Tactile sense is the only guide to prevent mishaps and carry the point of the needle approximately to the union of the anterior and lateral aspects of the vertebra. I am contented with pushing the needle 1 cm. further in, soon after its point has lost bony contact ventralward.

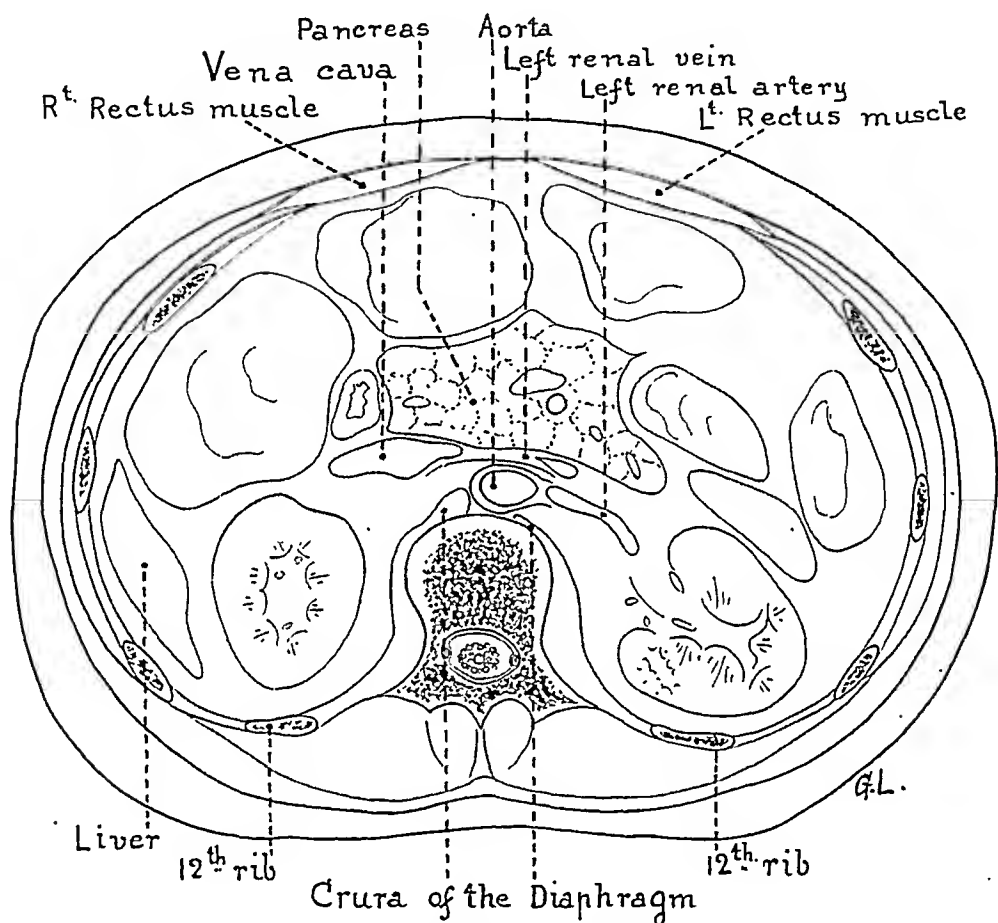


FIG. 14.—Diagrammatic illustration of the anesthetized areas (gray) resulting from the association of abdominal field-block with splanchnic analgesia.

The needle must not scratch the periosteum or be forced through the margin of the intervertebral disk which is prominent and rather soft. It must pass freely alongside the body of the vertebra and be tangent to the bone including its tendinous and ligamentous coverings.

Extent of Analgesia.—The analgesia resulting from bilateral injections of the sympathetic plexuses of the upper abdomen (splanchnic nerves and solar plexus) involves only a relatively small portion of the posterior abdominal wall, especially the area under the direct influence of the operative manoeuvres accomplished on the stomach, duodenum, pancreas and gall-bladder. The abdominal field-block which is always associated with the splanchnic in-

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jections controls the anterior wall of the abdomen within the limits of the recti muscles. There exists between these posterior and anterior anæsthetized areas (Fig. 14) lateral zones of normal sensibility which must be treated with respect. Packing must, therefore, be light and gentle, avoiding the lateral walls. Traction on the organs must be gentle and gradual until the full limit of operative requirement is reached.

REPORT OF CASES

CASE I.—C. B., male, age fifty-four years was admitted to the North Hudson Hospital, Weehawken, N. J., on October 31, 1923.

Chief Complaint.—Pain in the epigastrium for the past 12 years, intermittent and accompanied by vomiting. Hæmatemesis and melæna especially during the past 4 years. Loss of strength. Loss of weight (15 pounds in the last 3 years).

Physical Examination.—Color pale, nutrition poor, anemia. Teeth, many decayed. Lungs normal. Heart apparently slightly enlarged, sounds normal, no murmurs. Abdomen tender over the epigastrium and left hypochondrium, especially near the middle line; some rigidity, but no distention. Skin pale, yellowish. Temperature: 99°4. Pulse: 80. Respiration: 20. Urine examination: Negative.

Blood Examination.—On November 2nd, examination showed red blood cells 2,120,000 and hæmoglobin 20 per cent. The patient was transfused twice: November 5th (1500 c.c.) after which the red blood cells went up to 2,384,000 and hæmoglobin to 65 per cent.; and November 13th (1000 c.c.). Subsequent examinations made on November 14th and 30th showed red blood cells 3,600,000 and 4,112,000, hæmoglobin 60 per cent. and 62 per cent. respectively. Blood pressure varied between $14\frac{1}{2}$ and $16\frac{5}{8}$.

Provisional Diagnosis.—Gastric ulcer and possibly carcinoma of the stomach.

Operation.—On November 15, 1923, gastrectomy was performed under regional anæsthesia by Dr. Louis F. Lange of West Hoboken, N. J., assisted by Doctor Roberts and myself.

Palpation of the stomach revealed the presence of an ulcer near its lesser curvature, involving its posterior wall and adherent to the pancreas, practically about 2½ inches from the pylorus. Lesser and greater omenta ligated and stomach secured between two clamps applied parallel to the median plane of the body about 2 inches below the cardia. Stomach resected between the clamps. Distal segment turned over to the right and ulcer dissected leaving part attached to the pancreas. Duodenum sectioned and stump buried. Transmesocolic modified Polya gastrojejunostomy.

Operative and Post-operative Observations.—The operation lasted an hour and a half and was absolutely painless. The pulse was of good quality and remained practically unchanged throughout the operation. There was a short period of nausea while manipulating the stomach, accompanied by light sweats and pallor of the face; but there was no evidence of shock. Breathing was normal. The abdomen was completely relaxed. The post-operative course was excellent except for hiccough which lasted 3 days. There was no gastro-intestinal distention; no gas pain. The temperature was never higher than 99°4. Convalescence was easy and rapid. The patient left the hospital 18 days after the operation.

CASE II.—W. F., male, age thirty-four years was admitted to the United Hospital, Portchester, N. Y., on November 29, 1923, for operation the next day.

Chief Complaint.—Vomiting (6 months' duration) practically everything for the past two months. Pain in the epigastrium 1 to 2 hours after meals. Loss of strength. Loss of weight from 135 pounds to 119 pounds. His best weight had been 150 pounds.

Past History.—Perfectly well up to the time he was "gassed" in the World War (August, 1918), stomach trouble began soon after.

Physical Examination.—Cheeks sunken, color pale, nutrition poor. Foul odor to

breath. Tongue moist and covered with thick brownish fur. Teeth, many decayed. Tonsils enlarged and cryptic. Lungs and heart apparently normal. Abdomen soft and flat. Visible and palpable mass about the size of a small orange just above and to the right of the umbilicus. Temperature: $99^{\circ}4$. Pulse: 80. Respiration: 20.

Urine Examination.—Negative.

Blood Examination.—Red blood cells 5,000,000; leucocytes: 7,600. (Lymphocytes 29 per cent., polymorphonuclears 71 per cent.); hæmoglobin: 60 per cent.

Provisional Diagnosis.—Ulcer or carcinoma of the pyloric end of the stomach.

Operation.—On November 30, 1923, gastrectomy was performed under regional anæsthesia by Dr. Charles W. Walker of Rye, N. Y., assisted by Doctor Quinlan of Portchester and myself.

Exposure of the stomach revealed the presence of a large callous ulcer which had perforated into the head of the pancreas and involved the pyloric end of the stomach and the duodenum. The common bile-duct was not involved. Dissection of the ulcer from the pancreas leaving its base which was 5 cm. in diameter. Dissection of the duodenum continued into its second portion. Section of duodenum at margin of ulcer. Closure of duodenal stump. Resection of nearly two-thirds of the stomach followed by transmesocolic gastrojejunostomy end-to-side.

Operative and Post-operative Observations.—The operation lasted almost 3 hours and was absolutely painless. The abdominal wall, however, was reinjected to allow closure.

The pulse showed no change in strength and frequency. Respiration was a little shallow, but there were no signs of distress at any time; no signs of shock. The first manipulations on the stomach induced a nauseated condition which subsided rapidly by deep breathing. The temperature remained practically normal the days following operation, the highest being $100^{\circ}4$ on the second day. Urine output was 22 ounces the day following the operation and continued at the rate of 20 ounces daily. There were no gas pains; the abdomen was flat and soft. The patient was able to sit up in bed the next day by his own means and was up five days after the operation. His convalescence was easy and rapid. He gained $2\frac{1}{2}$ pounds in two weeks and left the hospital 19 days after the operation.

Preparation of Patients.—It is customary to lower the psychic element of the patient to a favorable level, in order to accomplish under the best conditions the various steps of the injection technic. Kappis¹⁶ orders veronal 0.50 gm. ($7\frac{1}{2}$ gr.) the evening before the operation and morphin 0.01 gm. ($\frac{1}{6}$ gr.) and scopolamin 0.0003 gm. ($\frac{1}{200}$ gr.) only half an hour before the operation is begun. Hoffmann⁹ gives 1 gm. of veronal the evening before, and 1 to $1\frac{1}{2}$ hours before the operation pantopon 0.02 gm. ($\frac{1}{3}$ gr.) and scopolamin 0.0002 - 0.0003 gm. ($\frac{1}{300}$ - $\frac{1}{200}$ gr.). Buhre's patients usually receive scopolamin 0.0003 - 0.0005 gm. ($\frac{1}{200}$ - $\frac{1}{120}$ gr.) and laudanum or narkoplin 0.03 gm. ($\frac{1}{2}$ gr.) or morphin 0.01 gm. ($\frac{1}{6}$ gr.). Nölle²¹ injects $\frac{1}{2}$ hour before the operation morphin 0.02 gm. ($\frac{1}{3}$ gr.) and scopolamin 0.0005 gm. ($\frac{1}{120}$ gr.). His patient is in twilight sleep during the operation and sleeps for several hours after. This dose is considered too high by those who are proficient in the art of inducing regional anæsthesia. Veronal given the evening before is a good procedure, provided the operation is performed in the morning. I am in the habit of ordering a hypodermic injection of morphin $\frac{1}{6}$ gr. and scopolamin $\frac{1}{300}$ gr. given one hour before the patient is brought in the operating room; but if the patient is still apprehensive a similar dose is repeated immediately before the anæsthesia is begun. In the cases reported today, Doctor Lange's patient received morphin $\frac{1}{6}$ gr.

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only just before the anæsthesia was begun, a procedure which must not be encouraged, the injection being, as a rule, ineffectual. Doctor Walker's patient was prepared in the usual manner. We must emphasize the necessity of blunting consciousness in every case, but we make it our duty to caution against the use of heavy doses of narcotics which might be detrimental to the patient and defeat the aims of the regional method.

Induction of Anæsthesia.—Regional anæsthesia in both cases consisted in the injection of the splanchnic nerves on both sides by the posterior route of Kappis associated with field-block of the upper anterior abdominal wall. Only one injection was made on each side of the body of the first lumbar vertebra, due consideration being given to the coefficient of correction of the costovertebral angle discussed in this paper. The contents of two capsules (1 gm.) of pure Neocaine* were dissolved in 200 c.c. of sterile normal salt solution, thus making a 0.5 per cent. solution, and 15 drops of adrenalin chloride solution (1:1000) added to it. Of the 200 c.c. thus prepared 40 c.c. were injected on each side of the vertebral column at the level of the first lumbar vertebra and the remaining 120 c.c. used for the abdominal field-block. Laparotomy was begun almost immediately after the last injection in the abdominal wall.

It is interesting to note that the 1 per cent. solution hitherto mostly recommended can be reduced to 0.5 per cent. without altering to any appreciable degree the quality of the analgesia required for operations on the upper abdomen; and since 200 c.c. is about the minimum amount of solution employed in these cases, the use of 0.5 solution for the splanchnic injections is more beneficial to the patient—especially if he belongs to the bad-risk group.

Pulse and Blood-pressure.—Kappis¹⁶ clinical observations are that "the pulse is generally accelerated, the blood-pressure sometimes sinking from 15



FIG. 15.—Case I. Mr. C. B. (Doctor Lange's patient.)
Before operation.

* Neocaine is a French product whose toxicity is very low. It is a powerful anæsthetic drug, which contains no adrenalin. It is sterile and readily soluble in normal saline solution. I have been using it for the last 6 years with very gratifying results.

to 20 mm. mercury sometimes unaffected and sometimes rising from 10 to 15 mm. mercury."

Hoffmann⁹ says that generally the frequency of the pulse is somewhat reduced from 4 to 12 beats. In one case reported by Metge²⁷ there was an imperceptible pulse of short duration, associated with considerable fall of blood-pressure (125 to 25 mm. hæmoglobin). My experience is that the pulse rate generally increases during the induction of anæsthesia, then gradually goes back to normal or a little below normal; the frequency and strength

of the pulse depending at the outset on the adrenalin contained in the solution and later on the condition of the blood-pressure.

Hoffmann⁹ found that if the induction of splanchnic analgesia preceded the abdominal field-block in some cases the blood-pressure fell from 3 to 20 mm. (Riva-Rocci), in others it remained unchanged. If the procedure were reversed the blood-pressure rose slightly. In 78 cases of the 104 cases reported by Metge²⁷ the blood-pressure dropped



FIG. 16.—Case I. Mr. C. B. (Doctor Lange's patient.) Three months after operation.

to below one-half of what it was before and after operation; but this did not seem to have great clinical significance. Schmidt¹¹ did not find any constant action of splanchnic anæsthesia on blood-pressure, and he believes that the psychic element seems to interfere with the results.

In most of my cases the blood-pressure was not taken during the operation, because the general aspect of the patient was satisfactory. But this does not mean that the blood-pressure was not influenced by the anæsthesia, for it must be remembered that in anæsthetizing the abdominal sympathetic system one must expect a fall in the blood-pressure due to loss of tonicity of the splanchnic vessels with a resulting flood of that territory at the expense of the peripheral circulation. Spinal anæsthesia is associated with similar disturbances of practically the same origin. These disturbances are, however, much greater in the case of spinal anæsthesia because of the extent of the territory involved in the anæsthesia needed for the upper abdomen.

After-effects.—The immediate after-effects associated with splanchnic

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analgesia are chiefly those brought about by the unavoidable disturbances in the blood-pressure, *viz.*, pallor, cold sweats, nausea, vomiting, slow and feeble pulse. Their occurrence, however, is not extremely common and far from being alarming. According to Kappis¹⁶ palor is more than when using other regional procedures, and is perhaps due to more rapid absorption of adrenalin or to reflexes resulting from anæsthesia of the splanchnic nerves or sympathetic system. My experience is that nausea is of frequent occurrence and ordinarily associated with pallor of the face. Vomiting is rare and is seldom disturbing to the surgeon, since the patient is asked to take a few deep breaths every now and then.

Kutscha-Lissberg²¹ in a critical review of his cases speaks of too rapid absorption of the anæsthetic drug with consequent intoxication, occasionally prompt collapse, and sometimes late conditions such as atony of the stomach and intestines. Similar reports have not yet come from men thoroughly familiar with the regional method and I personally have not made such observations.

I see no reason why there should be prompt collapse following the injection of novocaine in the retroperitoneal tissue. Intravenous injections of the anæsthetic drug or heavy doses of adrenalin might have caused the collapse. Late disturbances in the tonus of the gastro-intestinal tract can hardly be attributed to splanchnic analgesia which rather increases peristalsis during its period of activity.

Apart from the symptoms incidental to the fall of blood-pressure, which once established does not create further disturbances, splanchnic analgesia is not associated with untoward effects worthy of consideration.

Post-operative Condition.—Post-operative and post-anæsthetic conditions are ordinarily good. Vomiting is rare. Shock is considerably minimized, if at all present. The after-effects are certainly less severe with splanchnic analgesia than with general narcosis in operations on the stomach and the gall-bladder, which are those for which it is preferred. It must be emphasized that splanchnic analgesia does not prevent pulmonary embolism nor can it



FIG. 17.—Case II. Mr. W. F. (Doctor Walker's patient.)
Before operation.

improve pathological conditions present at the time of the operation, as is generally inferred; but it certainly minimizes the risk of pulmonary complications and leaves undisturbed the central nervous system and the liver, which are the organs on which life chiefly depends. In 112 operations under splanchnic analgesia Metge²⁷ had 3 fatal pneumonias; but he had 7 similar fatalities in an equal number of operations performed at the same time under general narcosis. Most writers are agreed that a good splanchnic analgesia

affords better operative facilities than general narcosis and does not interfere with the post-operative course of the disease.

CONCLUSIONS

Splanchnic analgesia is the most recent form of regional anæsthesia applicable to abdominal surgery, especially that of the upper abdomen. It has in the last five years, attracted the attention of many surgeons who have used it in a fairly great number of cases with very gratifying results.

Of the three original methods Wendling's is not recommended,

FIG. 18.—Case II. Mr. W. F. (Doctor Walker's patient.) Two months after operation.

Braun's has a few partisans, Kappis' enjoys the favors of the majority of writers and certainly has the greatest practical value.

Modifications of Kappis' technic are worthy of interest, because they caution against pitfalls and contribute to greater success.

Best results are obtained when the solution is deposited between the semilunar ganglia and the renal pedicles.

Variations exist in the inclination of the 12th rib on the vertebral column which are responsible for a certain number of failures. These failures can be reduced to a minimum by applying the coefficient of correction of the costo-vertebral angle, that is puncturing on the lower border of the 12th rib opposite the upper extremity of the first lumbar spinous process.

It is perfectly safe to approach the splanchnic area from the back. By keeping close contact with the vertebral column and following the technic described for that route it is impossible to make an intraspinal or an intravenous injection.

The concentration of the solution can be advantageously reduced from 1 per cent. to 0.5 per cent.

Splanchnic analgesia has a very great field. There seems to be no contra-indication to its use. It needs only be applied judiciously by those already familiar with the regional method.

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SUBLINGUAL FIBROMA

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IT is so rare to observe a chronic swelling involving the sublingual space that the diagnostic possibilities do not readily come to mind. The subjoined case therefore was of interest both for diagnosis and treatment. No similar type of growth has been found in the literature, although cases may have been overlooked, the difficulty of proper indexing being considered.

CASE.—Mr. C. R., aged thirty-nine years, was admitted to the New Haven Hospital, November 29, 1921, referred by Dr. F. N. Sperry of New Haven, Conn. He complained of a swelling under the tongue. For two and one-half years there has been an increasing difficulty in swallowing and in speech and an enlarging growth under the tongue and below the lower jaw. The condition has made a slow but steady progress. He has not had any visual disturbance, nervousness, irritability, tremor, sweating, palpitation or rapidity of the heart.

He had had measles, scarlet fever and typhoid fever as a child and inflammatory rheumatism seven years ago (1914) for nine weeks during which time he was in a hospital at Bridgeport. Otherwise his past history was unimportant.

The physical examination was normal throughout except for the local condition for which he entered. The tongue was large, moist and slightly coated; it was pushed upward, in its posterior portion almost meeting the hard palate. The swelling was slightly more prominent on the right than on the left side. The mass showed no signs of inflammation; it was firm, had a tense elastic feel, and seemed to be deep under the substance of the tongue itself. Nothing definite could be made out under the tongue anteriorly; it was not possible to examine the tonsils or pharynx because of the obstruction to the view. Externally there was a smooth enlargement of both submaxillary regions and a decided fulness in the submental area. Palpation gave the impression that there were several glands in each of these positions but they did not seem to have a connection with the deeper underlying mass. Bimanual palpation with one finger on the tongue and the other hand externally in any of the three triangles indicated that the swellings were continuous. The voice had a nasal quality, the patient talking as if his mouth were full. The thyroid gland and the isthmus could be palpated in the normal position.

The temperature, pulse and respirations were within normal limits. The red blood count was 5,200,000; Hæmoglobin 95 per cent. (T.). There were no abnormalities of the red cells. Blood grouping II Jansky. The white blood count was nine thousand and eight hundred with 72 per cent. polymorphonuclears. Eosinophiles, 4 per cent. Basophiles 1 per cent. Lymphocytes 18 per cent. Mononuclears 5 per cent. The urine examination was normal. The blood Wassermann test was negative.

In summary, we had a man of thirty-nine years, who complained of a slowly increasing difficulty in swallowing and speech. The condition had been present for at least two and one-half years; and on examination a smooth, non-tender, semi-elastic feeling

mass was present in the posterior sublingual region, pressing the base of the tongue upward against the palate, and bulging the submaxillary and submental triangles externally.

In an attempt to arrive at a diagnosis the following conditions were considered:

(1) *Cystic Conditions*.—*Ranula*—against this diagnosis was the freedom from involvement of the tissues under the tongue anteriorly—the position most frequently occupied by these cysts; the solid consistency of the tumor mass, although a tense cyst might feel similarly; and the failure of the growth to transmit light when attempts were made at transillumination. *Thyro-glossal cyst*.—No evidence of persistent sinus at the foramen cæcum (very difficult to examine) or exteriorly anywhere in the

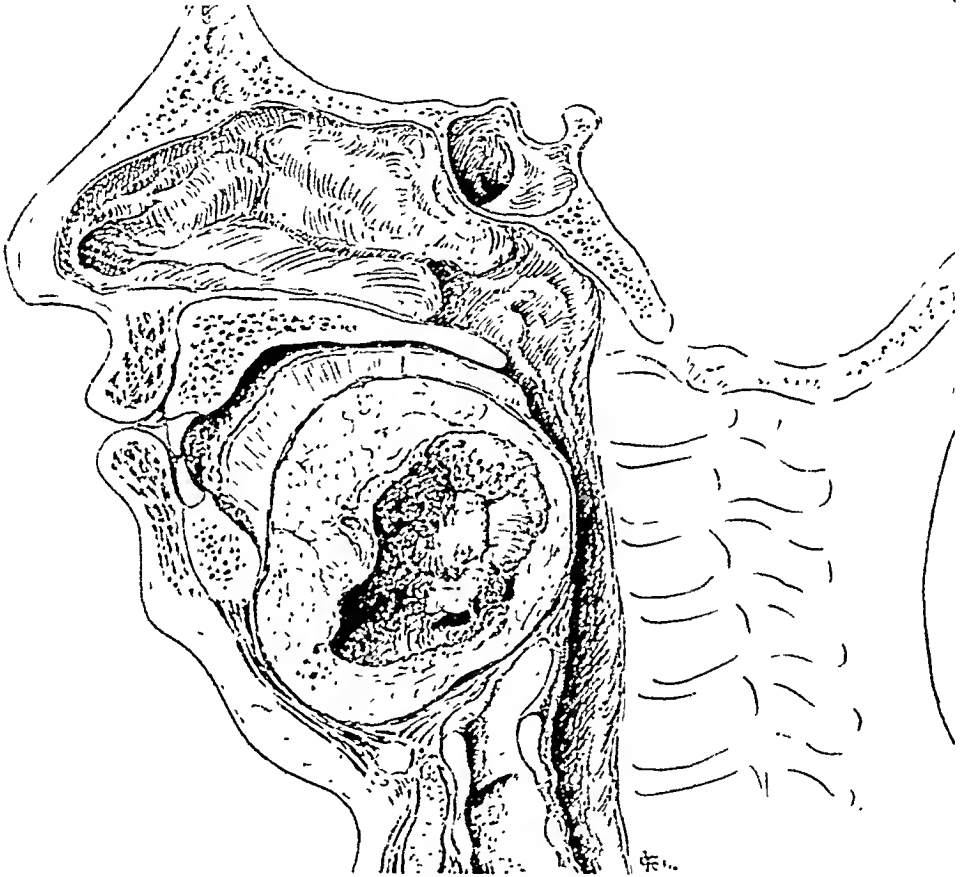


FIG. 1.—Cross-section of drawing (scale) showing the tumor in the position it occupied.

neck; and the same objections as to ranula, although the situation of the growth was not against a thyro-glossal origin. Dermoid cyst could not be ruled out.

(2) *Solid Tumors*.—Lipomas, fibromas, endotheliomas and mixed tumors have all been described as arising in the tongue itself and although reports of such tumors occupying the posterior sublingual region have not been found in the literature, there is no reason to believe that the growth might not take this direction. A case of sarcoma of the tongue "which sprang from the base of the tongue and grew downward and forward, causing a bulging beneath the chin", was described by Schulten¹. A lingual thyroid was also taken into consideration. Such a growth could occupy the exact situation of the tumor under discussion. Almost always these goitres are apparent in examining the posterior portion of the tongue itself. The lack of thyroid symptoms and the fact that the gland could be palpated in the normal position were against such a diagnosis.

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It did not seem possible to make the diagnosis without operation but the patient refused any radical procedure, although finally reluctantly consenting to the removal of a small bit of the growth under procaine anæsthesia.

November 30, 1921.—Operation. Exploration and removal of specimen for diagnosis. Under procaine a transverse incision one inch long was made over the most prominent portion of the swelling in the right neck. This incision was placed low in order to avoid the submaxillary gland. The tissue removed appeared solid in consistency and bluish white in color. The nervousness and apprehension of the patient

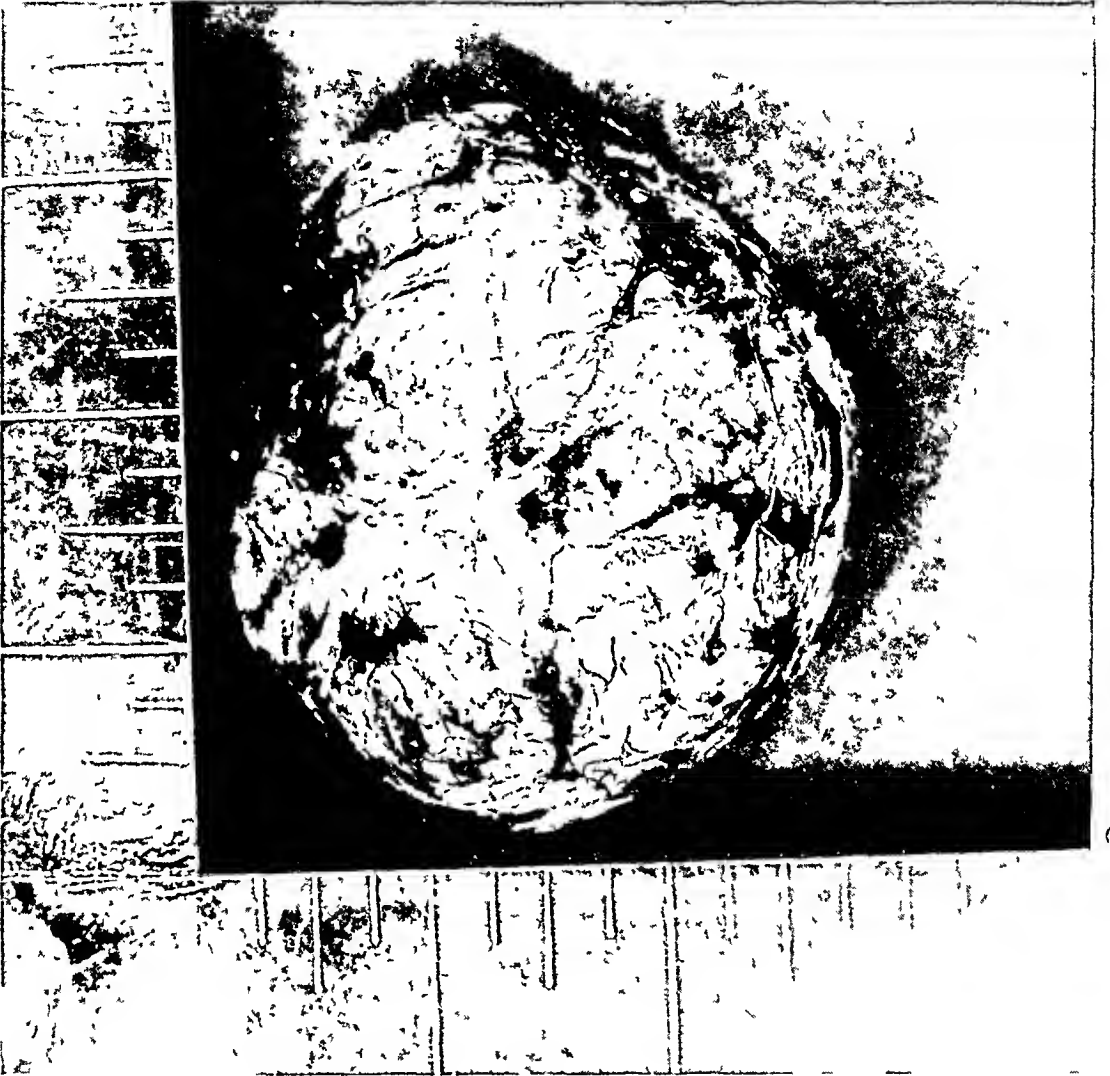


FIG 2.—Lateral view of the tumor. The scale is in inches.

made a more thorough examination out of the question. The specimen on pathological examination was reported to be a flattened out and compressed salivary gland.

Between November 30, 1921 and October 14, 1922, the growth was subjected to seven radium treatments but without noticeable result. He finally consented to operative removal of the growth.

October 14, 1922.—He was taken to the operating room and gas-oxygen anæsthesia given. During the course of the administration the patient became very cyanotic and stopped breathing. It was necessary to pull forward the tongue and to use artificial respiration. Finally just as a skin incision had been made for tracheotomy the patient took a breath. During this performance the operator had his finger over the base of the tongue pulling it forward in order to get a clear air-way and in this way

it was possible to palpate a large boggy tumor. It seemed to occupy the whole area of the tongue and anterior portion of the pharynx. The tumor felt as though it were full of fluid. On account of the difficulty in the anaesthesia the patient was returned to the ward, future operation to be decided on after a preliminary tracheotomy.

November 18, 1922.—Under procaine anaesthesia a preliminary tracheotomy was done low in the neck just above the sternal notch. The patient had considerable irritation, coughing, and a feeling of suffocation when the tube was introduced, but after 5 or 10 minutes he calmed down and stood the operation well. He returned to the ward in good condition. The tube was tolerated well and the patient breathed very comfortably.

November 21, 1922.—The second stage of the operation was undertaken. After a very difficult beginning, the patient was finally anaesthetized through the tracheotomy



FIG. 3.—Cross-section showing the degenerated cyst-like cavity.

tube, it being necessary to pack the naso-pharynx and also to introduce a mouth gag in order to prevent some breathing by the natural air-way. Operation was started with a transverse incision mid-way between the point of the mandible and the hyoid bone extending from the sternocleidomastoid anterior border to a similar position on the opposite side. The platysma was divided, the anterior belly of the digastric across its mid-portion, the mylohyoid and the geniohyoid and a portion of the geniohyoglossus. At the bottom of the incision, the anterior surface of the tumor, light pinkish in color came into view. A thin areolar tissue about the growth was divided and the mass separated from the surrounding tissue by gentle finger dissection. It occupied a position which pushed the posterior part of the tongue up against the hard palate. It also extended backward so that in getting around it, it was possible to feel the anterior border of the vertebrae (Fig. 1.) The growth was worked free all around and delivered intact with considerable difficulty through the small incision below the chin. There was very little bleeding. It was not necessary to tie off either the lingual or facial vessels, and the hypoglossal nerves on each side were retracted from the field of operation. A large dead space left by the removal of the growth was drained with two Penrose drains and suture was made with fine plain catgut approximating the divided muscles as accurately as possible. The skin incision was closed with silk.

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During the operation the upper pole of the left thyroid gland came into view and appeared to be normal. The patient stood the operation well and returned to the ward in good condition. The post-operative convalescence was without special incident.

December 2, 1922.—He was discharged. General condition excellent. Vital signs normal. Tracheotomy wound completely healed. Operative incision healed except where the drains were inserted. There had been no infection. No paralyses. Breathing improved and it was decidedly easier to swallow.

February 11, 1923.—Patient wrote a letter today saying he had gained thirty pounds since discharge from the hospital and was feeling fine.

Pathological Examination.—Grossly the tumor was a light purplish pink in color with occasional yellowish patches. It was slightly nodular, firm and surrounded by a thin veil of reddish areolar tissue. It measured 7.5 cm. by 7.0 cm. by 5.0 cm. in diameter (Fig. 2) and weighed 170 grams. It was cut open in its long axis, revealing a cystic area in the centre. This area measured 5.0 cm. by 4.0 cm. by 3.0 cm. in diameter. The walls of the cystic cavity were covered for the most part by a thin blood clot, reddish brown in color. There was also a considerable amount of yellow serous fluid. The mass of the tumor around the cyst was composed of solid pink tissue arranged in irregular clumps of interlacing fibrous appearance (Fig. 3).

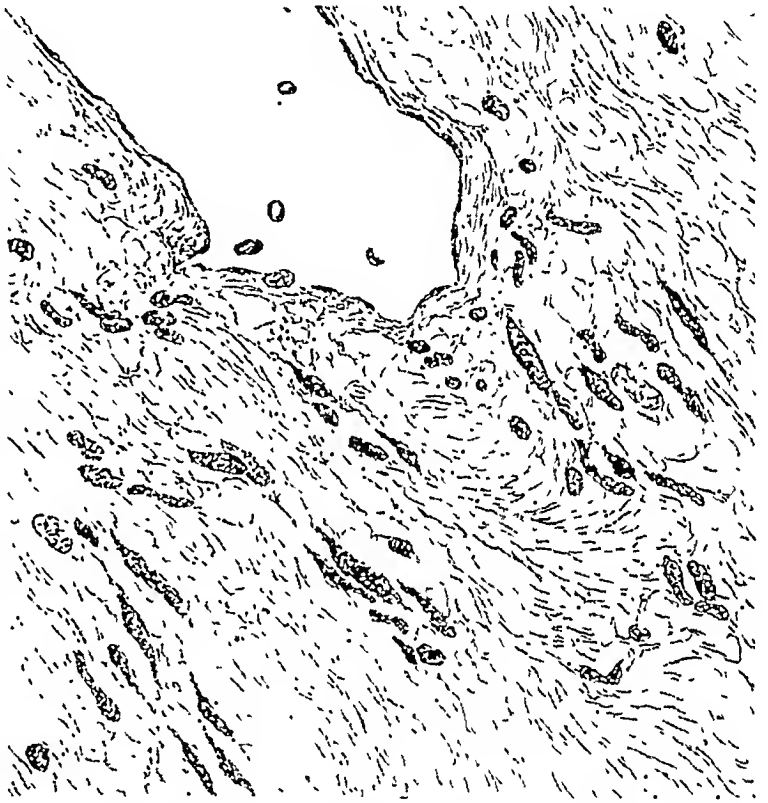


FIG. 4.—Drawing of microscopic section. The fibroblasts and fibrous intracellular tissue is well brought out. In the upper left hand corner is a large vascular space.

Microscopic examination showed a practically uniform picture throughout the five blocks examined. The sections consisted of elongated, faintly blue-staining nuclei interspersed with a large amount of pink fibrillar substance. There were occasional large endothelial-lined blood spaces. No true cyst wall was made out (Fig. 4). Special stains were made for muscle and nerve but no such fibrils could be demonstrated. The sections were examined by several prominent pathologists who all agreed on the diagnosis of fibroma.

It is interesting to speculate on the origin of such a growth. Owing to the fact that the aberrant thyroid is often seen in such a situation, it is possible that this tumor had its origin in the fibrous tissue remains of the thyroglossal migration tract. There are, however, so many other layers of connective tissue from which the tumor could have grown that no definite conclusion can be reached. The cystic area in the tumor may well have been a radium effect. There was no cyst wall so that we must assume that the broken down tissue was the result of necrosis caused either by the radiation or a failing blood supply. The position of the area in the tumor corresponded

exactly to the point where the maximum cross-fire radiation effect would occur; and it is also to be noted that the areas which would receive least raying on account of their position under the mandible and tongue, showed the most solid portions of the tumor.

Summary.—A chronic swelling involving the posterior sublingual region in a middle-aged man, was treated for about one year by radiotherapy without apparent effect. The growth was then removed through a submental incision and microscopic examination showed it to be a fibroma. No similar case has been found in the literature.

REFERENCE

- ¹ Schulten: Deutsch. Ztschr. f. Chir., vol. xxxv, p. 417.

ACUTE PANCREATITIS*

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AFFECTIONS of the pancreas due to trauma, either external on the abdominal wall, or internal, produced at operation, are not to be considered here, neither are the acute affections occurring in the course of a general pyæmic infection. The condition I am concerned with is the acute affection of the pancreas, appearing suddenly and incapacitating the patient in a short time, frequently leading to death. Text-books in general make a distinction between acute hemorrhagic pancreatitis, apoplexy of the gland, suppurative pancreatitis, and necrosis of the gland. Clinical observation however seems to point to the conclusion that these different varieties are really the same condition in various stages of development, or presenting different degrees of severity.

Owing to the many contributions to this subject, both by clinicians and by laboratory workers, the disease has become fairly well known. We may safely say that we know acute pancreatitis clinically, we know the associated conditions, but we do not definitely know its etiology. There are two viewpoints regarding the cause of the disease:

1. That it is due to the entrance of bile or duodenal contents into the pancreatic duct and that the symptoms are due to infection or to ferment action.

2. That it is an infection carried to the pancreas by means of the lymphatics.

Speaking of acute pancreatitis, of duct-borne infection, or of infection carried by the lymphatics all presuppose that we are dealing with a bacterial invasion. A study of the literature, however, and my personal observations lead me to doubt that this assumption is correct. For this reason I desire to present the histories of six rather carefully observed patients, which seem to support the theory that infection as such has nothing or little to do with acute pancreatitis, but that it is due to the action of liberated pancreatic ferments on the surrounding tissue.

CASE I.—F. H. A man thirty-nine years old, admitted to the Lenox Hill Hospital, forty-six hours after the onset of an acute abdominal condition. Two days previously he had enjoyed a good dinner and was feeling fine when he was suddenly seized with severe colicky pains in the epigastrium, accompanied by vomiting. His physician made a diagnosis of cholelithiasis and administered morphin which temporarily relieved the pain but did not control the vomiting. His condition grew worse, he went into collapse, and a diagnosis of perforation of the gall-bladder was made and the patient sent to the hospital. On admission he was found to be gasping for air. His skin was blue and cold and covered with perspiration. The pupils were dilated to maximum. There was constant vomiting of yellowish non-odorous fluid. His pulse was not perceptible

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and enjoyed it. A hypodermic of morphin brought temporary relief, and then the pain returned. The next morning she began to vomit and continued at short intervals all day, when it stopped after a morphin injection. Since that time she had not been free from pain but vomiting had not recurred. The patient gave a history of recurring attacks of pain in the upper abdomen since her last child was born one and a half years ago.

On admission her temperature was 99.8, pulse 98, respiration 22. She was a very obese woman which made examination difficult. She was slightly jaundiced, but did not look very sick. She still complained of severe pain in the epigastrium, to the right and particularly to the left of the median line. The abdomen was somewhat distended. There was no rigidity and no free fluid could be made out. There was marked tenderness over the entire upper abdomen, most marked over the gall-bladder region. A blood-count was not done. The urine contained a faint trace of albumen, but was otherwise negative. She impressed as a typical gall-bladder case and was operated on with that diagnosis.

A right rectus incision was made. A large amount of clear yellow fluid was present. As soon as the gall-bladder region was exposed fat necroses were noted in the fat surrounding it, as well as in the omentum and the gastro-hepatic omentum. They were scattered all over, but were most numerous about the pylorus and in the tissue overlying the pancreas. The gall-bladder was about normal size, did not look acutely inflamed but was tense and thick-walled. Bile could be pressed out. Stones were not felt. The duodenum was mobilized for exploration of the bile duct. No stones felt and no distention noted, although its lower end was surrounded by hard nodular pancreatic tissue. Attention now directed to the pancreas which was enlarged and hard. It was approached through the gastro-colic omentum. No gangrene or areas of softening noted. Three gauze tampons were inserted to the prepancreatic area and the abdomen was then partly closed.

On the second night the temperature went to 102.4, but by the fifth day it reached normal. The post-operative course was without incident. The drains were removed on the tenth day. There was at first profuse serous secretion containing small shreds of necrotic tissue. The secretion had no irritative action on the skin. Except for the presence of albumen for a few days after operation the urine remained normal. She was discharged healed on the thirty-fifth day. Since that time the patient has remained well except that she is troubled with hyperacidity. She is pregnant at present about four months, but this apparently has not produced any abnormal symptoms.

CASE IV.—Mrs. L. C., thirty-eight years old, admitted September 13, 1921. Sudden onset day before with excruciating pain in the upper abdomen. It had been continuous ever since and so severe that she had been unable to rest. Shortly after onset she began to vomit, and this also had continued steadily. Her bowels had moved, and there were no urinary symptoms.

One year ago she had a similar attack, but not so severe. It responded to medical treatment. Since then she has had several minor attacks. She thinks they came on following an abortion. She has never been seriously ill. Her first child was delivered by Cæsarean section ten years ago. After that she had three children born normally, but the fifth was again delivered by Cæsarean.

On admission she was in extreme pain, tossing about in bed. Her skin and sclera had a yellow tinge. Her tongue was coated and the throat congested. She vomited frequently, just clear fluid, and belched considerably. The pain was situated in the epigastrium, spreading to both sides with equal intensity. The abdomen was not distended. There was no hernia through the scar. No peristalsis was noted. Palpation revealed slight rigidity over the entire upper abdomen, with very marked tenderness, somewhat more acute on the left side, but passing around both sides to the back. The temperature was normal, the pulse 70.

On the basis of the sudden onset with continuous severe epigastric pain, almost

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constant vomiting, slight rigidity with very marked tenderness of the upper abdomen and the absence of inflammatory signs, a diagnosis of acute pancreatitis was made. Operation was advised but refused, and because the symptoms were not grave, we did not urge, especially as we were interested to know whether spontaneous cure would result.

On the following day the pain was somewhat less, most intense in the left upper abdomen. The jaundice had deepened somewhat, bile was present in the urine and the bile color index of the blood was 7 as compared with 2-4 normal. The pulse was 60, temperature 99.8, white blood-cells 16,800, polymorphonuclears 94 per cent. Tenderness and slight rigidity were unchanged and had extended to the lower abdomen. Vomiting continued. A duodenal tube was introduced but promptly vomited. On September 15, the fourth day after her disease began, the temperature gradually rose to 102.2, pulse 106, respiration 24. Pain became more severe. Slight rigidity and very marked tenderness, especially to the left of the median line, persisted. The white blood-cells were 16,400, polymorphonuclears 92 per cent. The diagnosis of acute pancreatitis was maintained, operation was urged and was accepted.

A median epigastric incision was made. A large amount of hemorrhagic fluid was found. Fat necroses were scattered over the abdomen; they were most numerous in the transverse mesocolon, about the duodenum and over the pancreas. An incision was made in the transverse mesocolon and the pancreas exposed. It was large and hard and surrounded by fat necroses and gangrenous looking tissue, a portion of which was removed for microscopical study. The entire head of the pancreas seemed involved. Considerable bleeding was encountered, due to the sloughing nature of the tissue and there was much difficulty in controlling it. The peri-pancreatic tissue was bluntly entered in several places and three gauze tampons were then inserted. Cultures were made from the peritoneal and retroperitoneal exudate. The gall-bladder was then opened. It was not acutely inflamed, but its walls were thickened. Several stones were removed and cholecystostomy then done. Her convalescence was a stormy one. On the third day she developed an unexplained œdema of the face which closed her eyes and lasted several days. The tampons were removed on the thirteenth day. The discharge was profuse and at times contained necrotic fragments of tissue and on the fifteenth day also considerable blood. It never produced excoriation of the skin. Laboratory findings were: 1. Wassermann negative. 2. Examination for pancreatic ferments in the discharge and feces were negative. 3. The urine contained albumen for several days, bile only on the first day, and never sugar. 4. Cultures of the peritoneal and retroperitoneal exudate were sterile. 5. Cultures taken from the gall-bladder secretion on the ninth day contained colon bacilli. 6. Examination of the necrotic peri-pancreatic tissue removed at operation showed necrotic and suppurative fat tissue with hemorrhage. 7. Necrotic tissue discharged post-operative showed degenerated tissue composed of indistinct cells, and arranged in small groups, suggesting acini, probably necrotic pancreatic tissue.

CASE V.—Mrs. A. C., twenty-five years old, was admitted January 27, 1922, complaining of pain in the upper abdomen which had started three weeks ago. She had had similar attacks at irregular intervals during the last two and a half years, the first one coming on a week after her last confinement. Each attack had started in the right upper quadrant, had then spread over the entire upper abdomen, and had been accompanied by frequent vomiting. Her present attack was the most severe. It had started in the middle of the night with excruciating pain and vomiting which continued uninterruptedly. She was seen by me in consultation on the third evening after the onset, and seemed to be suffering intensely. She was a big adipose woman, rather apathetic, and answered questions reluctantly. She looked pale, her eyes were sunken and underlined by deep rings. Pulse poor quality, 72. The temperature was subnormal. She seemed to be in shock. The abdomen was collapsed and soft all over. No rigidity at all. No organs palpable. Over the entire upper abdomen there was marked superficial and deep tenderness.

Removal to hospital was advised, but was refused by the patient, and she was lost sight of until she was admitted almost three weeks later. She stated that in the meantime her pain had gradually shifted from the right upper to the left upper abdomen, where it had remained as a steady dull pain, radiating to the back at the same level. For the first two weeks she had vomited whenever she took food, but less often during the last week. Her sleep had been disturbed by a great deal of pain, and she had lost fifteen pounds in weight. There had been no jaundice. Her bowels had been regular, and no blood had been noticed in the fæces. The temperature was 98.6, pulse 92, respiration 20. The physical signs had changed a great deal since the first examination. The abdomen was soft and relaxed, there was no superficial tenderness or rigidity. On deep pressure there was tenderness across the entire upper abdomen, most marked in the epigastrium and to the right of it. Corresponding to this tenderness a mass could be palpated which reached from the ensiform to the umbilicus and was nearer the surface in the median line than on either side. Its lower border was sharp and corresponded in general to the outline of an enlarged liver. It could be followed to the left as far as the costal margin. There was no tenderness or swelling in either costo-vertebral angle. No free fluid could be made out.

The patient was operated on the following day. Epigastric incision just to the right of the median line. No free fluid. Numerous fat necroses were found scattered throughout the omentum and in the fat surrounding the pancreas. The liver was small and soft. The gall-bladder showed no adhesions, its walls were thickened and it was filled with small stones. The posterior wall of the stomach was adherent to a large cystic mass occupying the region of the pancreas. The lower border of this mass was hard and nodular, and was formed of gastrocolic omentum which had been drawn backward in order to wall off the mass. It was this rather sharp border which had been mistaken for liver edge prior to operation. When lifting up the transverse colon a thickened nodular mass could be seen and felt surrounding the exit of the duodenum. Fat necroses were found scattered throughout the tissue.

It seemed then that we were dealing with a pancreatitis which had quieted down and which had formed a pseudo cyst retroperitoneally. A cholecystectomy was done first, beginning the dissection at the cystic duct. The pancreatic region was now entered by bluntly going in between the stomach and the transverse colon. The peritoneum was found to be much thickened. A large cavity, situated behind the stomach, was entered, and at least a pint of turbid fluid containing flocculi evacuated. A rough mass could be felt in the cavity, which after extraction proved to be a slough of the pancreas, perhaps about half the gland. A cigarette drain and one rubber tube were inserted into the cavity and another cigarette drain to the gall-bladder region, and the wound was then closed to the drain. The convalescence was uneventful. On the day after operation the temperature rose to 102, but reached normal by the sixth day and remained that way. Drainage was profuse for the first few days, at no time, however, excoriating the skin. On the ninth day the gall-bladder drainage and all sutures were removed, and on the fifteenth day also the drainage tube from the cyst. The patient was discharged completely healed after six weeks.

Laboratory Findings.—Urine negative for sugar all the time. Albumen present after operation, then disappeared. Blood count on admission: White blood-cells 9400, polymorphonuclears 73, hæmoglobin 60 per cent. Wassermann negative. Pancreatic cyst-fluid negative for pancreatic ferments. Cultures from the peritoneal fluid, the pancreatic cyst fluid and gall-bladder were all negative.

Pathological Examination.—Inflamed gall-bladder, containing many stones. No bacteria in wall. Pancreatic slough so necrotic that structure could not be recognized.

CASE VI.—Mrs. C. F. was admitted August 27, 1923, complaining of abdominal pain and vomiting. It had started two days ago with excruciating pain in the epigastrium which within fifteen minutes had spread diffusely throughout the entire abdomen. Soon after she developed pain in the back, just below the costal margin. From here the pain

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radiated to both shoulders. It came on in frequently recurring spasms, did not seem to radiate from the epigastrium to the back, but in each area increased in severity simultaneously. Soon after the onset of pain she began to vomit at frequent intervals, and the night before admission she had vomited every fifteen minutes. The vomitus was greenish-yellow fluid without disagreeable odor. The bowels had moved and the stools had been normal.

The patient stated she had a similar attack two years ago, which lasted about two hours and was less severe, though accompanied by chills, fever, backache and vomiting. She had also had a slight attack nine years ago following a dilatation and curettage. Aside from the above attacks she had always been well. Her menstruation was normal. The clinical picture was that of a patient in acute distress. She was unable to keep still, was tossing in bed, moaning with pain, and vomiting every little while. She begged that something be done to relieve her. The abdomen was slightly distended. There was no rigidity, and no free fluid could be made out. There was very marked tenderness, even on light pressure, over the entire upper abdomen, and extending downward on the right side, but most marked in the epigastrium. No organs could be made out. There was no icterus. Vaginal examination elicited much tenderness, but there was nothing abnormal to be made out. Her temperature was 99.4, pulse 96. The urine showed a heavy trace of albumen. No sugar. Blood examination showed white blood-cells 18,800, polymorphonuclears 88 per cent. A diagnosis of acute pancreatitis was made and operation was performed within a few hours after admission. A four-inch incision was made through the upper right rectus. Only a little fluid and scattered fat necroses were seen at first. The abdomen below the transverse mesocolon was free from fluid and showed no other involvement. It was therefore protected with pads, and attention directed to the upper abdomen. A hemorrhagic exudate surrounded the liver and stomach, and infiltrated these organs. There was also a large amount of bloody fluid behind the peritoneum, surrounding the pancreas and duodenum, extending downward on the right side behind the peritoneum of the ascending colon. There was extensive necrosis of the tissue surrounding the pancreas. The transverse mesocolon had been drawn backward and was adherent over this necrotic mass. The walls of the stomach were red and injected and intensely oedematous. The gall-bladder was normal in appearance, thin-walled, but filled with small stones. There were no adhesions. It was quickly removed, and the tissue overlying the pancreas was then bluntly entered, evacuating considerable sanguineous exudate. Three gauze tampons were placed into the peri-pancreatic tissue and a cigarette drain to the gall-bladder stump. Abdomen then closed in layers. At the end of the operation the patient was in considerable shock, she was cyanotic and the pulse was hardly perceptible. Under appropriate treatment she improved somewhat, but died about ten hours after operation, giving the clinical picture of a severe case of pancreatitis which has not been operated on. The impression we had was that operation had been carried out too late.

Etiology of Acute Pancreatitis.—About 300 years ago the pancreas was still considered to be simply a pad for the support of the stomach and the protection of the large vessels. In 1642, Wirsung succeeded in finding the excretory duct and since then this organ has been known to be a gland, but it was not until the middle of the last century that Claude Bernard emphasized the importance of the pancreatic juice in the digestive process. The first reliable reports concerning diseases of the gland date back to this period, but only during the last twenty or thirty years has the field of pancreatic diseases been opened to the surgeon.

Acute pancreatitis is one of the diseases that has become generally known more recently. For our first knowledge concerning fat necrosis we are indebted to Balser, who in 1879 wrote his famous article on "Fat

Necrosis, a disease of man often ending fatally". However, he did not recognize the intimate relation between this condition and pancreatic disturbance, but considered it an idiopathic disease. He performed many autopsies to study the condition and frequently found these little opaque yellowish-white spots in the region of the pancreas in people who had died of a variety of diseases. He called attention to the fact that nearly all patients in whom fat necrosis was found were over forty years of age and were usually well developed, rather adipose subjects. He also looked for this condition in animals, especially those rich in fat, and frequently found fat necrosis in the pancreas and its vicinity in Hungarian pigs without any disturbance of their general well being. In animals poor in fat and in German pigs he rarely found it. Williams made similar observations in two hundred American pigs examined. After Balser's reports considerable attention was paid to this subject, but whether fat necrosis or pancreatic disease was the primary affection remained in dispute for a long time. Fitz deserves the credit for first emphasizing the primary affection of the pancreas. As a result of his studies and a review of the literature he expressed the conviction that fat necrosis is always secondary to disease of the pancreas. In the course of time various theories concerning the nature of the disease were advanced. The infectious theory was the most popular and still has many adherents. Heava believed the disease depended on the entrance of hydrochloric acid into the excretory duct. Rolleston on the other hand believed it to be a tropho-neurosis. As a result of extensive animal experiments the theory that the disease is due to the activity of ferments probably has the largest number of adherents to-day.

Several of the symptoms, and also the course of the disease, seems to point to infection as the cause. Microorganisms have been found by several authors in the pancreatic tissue itself, as well as in venous thrombi in the gland and in its surroundings. They have also been found in the peritoneal exudate and in the vicinity of the fat necroses. But as bacteria are often found in dead bodies, several authors have tried to isolate them during life, and they have tried to induce fat necrosis by means of the injection of bacteria. In several instances they succeeded in producing typical fat necrosis by the injection of bacteria into the pancreas directly, or into its excretory duct. The most prominent present advocates of the infectious theory, are Deaver and Pfeiffer who have contributed extensively to this subject. They have found clinically that infection may spread to the pancreas by way of the lymphatics from an inflamed gall-bladder, a gastric or duodenal ulcer, or chronic appendicitis, and they have shown experimentally the possibility of such extension. Barber has also in a recent article expressed the belief that infection is carried from a cholecystitis through the portal vein to the liver and that it then descends through the lymphatics to the lymph-nodes and the pancreas, producing milder forms of pancreatic lymphangitis. But in spite of these findings the infectious theory does not seem to explain the condition. No acute inflammation has been demon-

strated in the fat necroses, and bacteria have been but rarely found in the necrotic foci or their vicinity. Truhart does not believe in this theory and states in his monograph that the pancreas of men is not susceptible to bacterial invasion, and that the excretory duct but rarely allows bacteria to enter. Archibald and Gibbon also do not believe in the lymphatic origin, and in commenting on Deaver's work dismiss it by saying that it is still under discussion, and in any event is hardly susceptible of absolute demonstration, it lacks as yet experimental proof, depends upon purely clinical inferences, and goes on the whole contrary to the rules of pathology.

Our principal knowledge concerning this acute affection has been gained by animal experiments, because in man it often runs such a short and stormy course that long observation is impossible, and in addition to that the situation of the gland precludes easy access. We have tried in a few cases to learn something by means of the duodenal tube, but the incessant vomiting made it impossible to keep the tube down. In order to carry out successful animal experiments it is necessary to produce conditions which may appear spontaneously in the human body. Many authors have taken this into consideration and they have proved in this way that fat necrosis may be produced by local disease of the pancreas such as artificial inflammation, stagnation of its secretion, flow of pancreatic juice into the retroperitoneal fat, etc.

Langerhans made a suspension of fresh pancreas in distilled water, injected it into fatty tissue and produced fat necrosis. He first called attention to the fact that their development depended on the splitting of the fat into its component parts, glycerine and fatty acids. Hildebrandt produced fat necrosis in animals by means of steapsin, and hemorrhages by means of trypsin. They were brought about by simple stasis of the secretion or of the return flow of blood, or by laceration of the pancreas. These experiments were later repeated by Williams, who tied off a part of the pancreas and lacerated it and produced fat necrosis in cats. We also have had occasion to repeatedly note extensive fat necrosis in dogs which died suddenly after operations on the duodenum. They were probably the result of lacerations of the pancreas with entrance of the juice into the retro-peritoneal tissue.

Of greatest importance for the theory of ferment action was finally the demonstration of fat splitting ferments in the necrotic foci, by Flexner. He proved that pancreatic juice may flow into the peritoneal cavity without producing inflammation, and further that sterile pancreas or pancreatic juice may produce fat necroses. As the result of his experiments he came to the conclusion that infection as such played no rôle at all, or only a minor one. The final result of his work led him to state that fat splitting ferments can be demonstrated in fat necrosis at certain times, especially in the early stages, and that later they may disappear entirely. Though it is not possible to state positively that steapsin is the direct cause of fat necroses, it most probably is, because it can always be found in them and it is not present

in normal fat. The permeation of pancreatic juice into the peri- and para-pancreatic tissue is the cause of fat necrosis, and this permeation is made possible by laceration of the pancreas or circulatory disturbances.

Hess showed that the injection of a few c.c. of sterile olive oil into the duct of Wirsung would produce necrosis of the pancreas and surrounding fat. The animals died under similar circumstances as human beings, and the autopsy findings were identical. Injection of glycerine did not produce these results. From these findings the following conclusion was drawn : Contact of fat and pancreatic juice in the duct splits up the fat and produces soap. This soluble soap passes from the duct into the pancreatic tissue, destroys it and opens the way for pancreatic juice into the surrounding fat. The latter is split and necrosis develops and forms the nucleus for a spreading necrotic process. These experiments are more successful at the height of digestion because at that time the gland is filled with juice.

Similar conditions may play a rôle in the human body, because at the height of digestion the duodenum contains much fatty material, and the pancreas much juice. Compression of the duodenum may be brought about by a full stomach or by muscular action, and some of its contents may enter the common bile duct and the duct of Wirsung. Such an occurrence is more easily conceivable in the presence of a dilated papilla, which may have been injured by the passage of a gall-stone. In this connection it is interesting to note that the onset of the symptoms of acute pancreatitis in many patients is definitely given at the height of digestion, a few hours after a heavy meal. But even without injury to the papilla one must admit that relaxation of the sphincter may at times allow the entrance of duodenal contents. We do know that sphincters guarding other viscera under certain circumstances allow regurgitation, as for instance the pylorus, the ureters, the ileocaecal valve, etc. It is also commonly assumed that inflammation may spread from the duodenum to the bile ducts and produce catarrhal jaundice.

Other experiments consisted in ligating the excretory duct of the pancreas in dogs at the height of digestion. As a result of the tension produced in the ducts they ruptured and allowed extravasation of pancreatic juice into the surrounding tissue, producing typical necrosis. The same technic employed in starving animals did not produce necrosis, the secretion of an active juice was inhibited, and fibrosis of the gland initiated. In a human being such stagnation of juice may develop as the result of spasm of the papilla or by the incarceration of a gall-stone in that part of the common duct where it passes through the pancreas and where it is able to compress the duct of Wirsung. Several such cases have been reported.

The injection of bile into the excretory duct likewise produces necrosis of the pancreas and fat, probably the result of the activation of steapsin by the bile, and owing to the combination of pancreatic juice with the fatty substances contained in bile. That this mode of development is possible in man due to the incarceration of a gall-stone at the papilla has been proven chiefly by Opie and Korte.

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As the result of experiments and clinical observation Archibald and Gibbon have come to the conclusion that in cases of acute pancreatitis bile most likely flows into the pancreas, and they believe that three conditions must be present to make this possible. (1) There most likely is a change in the composition of the bile, increasing the proportion of bile salts. (2) There must be undue resistance, perhaps amounting to spasm of the common duct sphincter. (3) There must be an abnormal rise of pressure in the biliary system behind, either in the gall-bladder or in the common duct.

Mann and Giordano have undertaken the most recent and very extensive research into the problem of the causes of pancreatitis. Unfortunately only a part of their results are so far available. Their first publication deals with the bile factor in the production of the disease. They have studied this subject experimentally, and on the basis of anatomical findings in man, especially the relation of the bile duct to the pancreatic duct. After the most painstaking observations they have come to the conclusion that although reflux of bile into the pancreatic duct may occasionally take place, this cannot be considered the cause of acute pancreatitis.

Bearing in mind all the experimental data submitted so far, as well as the reports of careful clinicians, and in that light review our own six cases regarding their etiology, it would seem.

1. That infection by means of lymphatic extension played no rôle in any of the cases. Had there been an infection in any other organ leading to such an acute condition in the pancreas there should have been symptoms of such an infection. But that was not the case. All patients were stricken suddenly, while apparently in excellent health, and the symptoms were at once referred to the epigastrium or at least to the upper abdomen. In none of the patients was there early temperature or rise in pulse. The blood-count was high, but that may be so in conditions not strictly inflammatory in character. In addition to this no acute inflammatory signs were observed in any organ at the time of operation, and the cultures taken from the peritoneum and the retroperitoneal tissue as well as from the gall-bladder, were all negative. The tissues from Case I, which came to autopsy, showed no acute inflammation except in the fatty tissue surrounding necrotic areas, where it formed a protective barrier.

2. That regurgitation of duodenal contents may have played a rôle. Such regurgitation is theoretically possible, unfortunately it can neither be proved nor disproved. In three patients the onset of acute symptoms occurred at the height of digestion, a few hours after a heavy meal, when conditions for regurgitation and for the development of pancreatitis were favorable.

3. That the gall-bladder and bile probably in some way were connected with the development of acute pancreatitis. In five patients gall-stones were found and in the sixth a diseased thickened gall-bladder. Just what the relationship was, whether bile actually entered the pancreatic duct, or whether a gall-stone or spasm of the sphincter temporarily obstructed it and caused

increased pressure, with subsequent rupture of the pancreatic duct, is impossible to state positively. It does appear though that something took place to affect the entire gland at once, for the onset in all cases was acute and very severe. The fact that in two patients jaundice was noted, also speaks for the close association of the two conditions. In Case III, the diagnosis of cholecystitis rested partly on the fact that she was jaundiced, and in Case IV, in addition to the icteric tinge of the skin, bile was found in the urine, and the bile color index of the blood was considerably increased. Granted that bile may enter the pancreatic duct under certain conditions, and this is admitted even by Mann and Giordano, the next question is whether normal bile is able to produce acute pancreatitis. The two last named authors practically deny this while Archibald and others have experimental proof that it is possible. This question however, is of not so much importance clinically, because in the patients in whom gall-bladder disease and acute pancreatitis have been found associated the bile has not been normal. It may have been sterile, but its chemistry had been altered. Archibald states that in infected bile it is pretty certainly not the bacteria acting in their infecting capacity that cause the pancreatic lesion, but rather the chemical change in the bile produced by the action of bacterial growth. This is the conclusion I have also reached as the result of observations in my patients.

That in Case I, the destructive process started in the pancreatic duct is evident from the nature of the lesion found at autopsy. In the other cases no doubt a similar progression took place, leading to complete recovery of the tissue in two patients and necrosis of the tail portion in two others. Only a process acting through the duct or the circulation can affect an entire gland so suddenly and so severely. None of the patients had any inflammatory symptoms preceding the acute onset, and even after the onset some time elapsed before temperature and increased pulse developed. This increase is probably the reaction to a chemical irritant, and not the result of a primary inflammation. Cultures taken during the acute stage from the peritoneal fluid, the retroperitoneal exudate and the gall-bladder showed no organisms. In each case the gall-bladder showed chronic inflammation, but no acute signs.

Any other factors sometimes named in the etiology, such as pregnancy, alcoholism, obesity, etc., are probably simply contributing factors, in that they bring about conditions favorable for the development of chemically altered bile or for spasm of the sphincter and congestion of the liver. It is well known for instance that during pregnancy, women have a high cholesterinemia and that gall-stones are apt to form. It is then the presence of the gall-stones and the induced chronic cholecystitis, which is directly responsible for producing pancreatitis, and not the pregnancy. In Cases III and V, symptoms dated back to their last pregnancy and in Case IV, to an abortion. In alcoholism it is probably the hyperacidity and congestion of organs which bring about conditions favorable for spasm of the

sphincter, and at the same time congestion of the liver, which may raise the pressure in the biliary system to such a degree that bile passes over into the pancreatic duct. Mann and Giordano state that in only a small percentage of human beings is it anatomically possible for bile to pass over into the pancreatic duct. Granted this is so, one may answer that by saying acute pancreatitis is a rare disease as compared with gall-bladder disease, and that it is only in that small percentage of patients in whom the necessary anatomic, physiologic and pathologic factors are present, that acute pancreatitis develops.

Symptoms and Physical Signs—Pain is by far the most important and persistent symptom. It is at once severe and overwhelms the patient with the suddenness of its onset. It is colicky in character, is situated in the upper abdomen, in most patients in the epigastrium, in others more to the right or left. It frequently radiates to the back and shoulders. One patient described a feeling as of a girdle pain, constricting her entire upper abdomen. The pain is of such severity that patients are unable to rest, they moan and toss about and beg for relief. Sometimes pressure eases the acuteness, at other times morphin, but as soon as that wears off, the pain returns. It may come somewhat intermittently (Case IV), as it does in intestinal obstruction, but usually it is steady and never lets up.

Vomiting is the next most important symptom, and in the more severe cases recurs every few minutes. It is distressing to see such a patient in pain retch and strain trying to bring up a small amount of fluid. Vomiting may continue very frequently for a day or more and then stop, or it may continue until operation or death. In one of the patients it lasted for two weeks. The vomitus is usually yellow in color, has no abnormal odor and no other unusual characteristics. After vomiting ceases, hiccough and retching may continue as evidence of irritation in the upper abdomen.

Collapse symptoms are frequently present, they are more or less severe depending on the intensity of the attack. They were observed in three of my patients, and indicate severe disturbance as evidenced by the fact that two of them died. In the very severe cases with hemorrhage or extensive necrosis cyanosis may be present and death may occur within a few hours or days.

The physical signs depend on the stage during which a patient is seen and on the severity of the attack. Most patients now come under observation in the first few days and during this period the signs point to some acute lesion in the upper abdomen. What has struck me as most interesting is the lack of physical signs as compared with the severity of the symptoms. This has been true in two of my patients to such a degree that the house staff ventured to suggest that they were simply neurotic. At the time they came under observation four of my patients had no rise in temperature and the pulse rate was not increased. The abdomen was only slightly distended and there was slight rigidity or none at all. The most marked sign was exquisite tenderness over the entire upper abdomen, perhaps

most marked just above the umbilicus and to the left of the median line. Such exquisite tenderness with only slight rigidity or none at all, and the lack of other signs has seemed to me to be additional evidence that we were not dealing with an inflammation due to infection, but rather with a chemical irritation of the peritoneum. Other aseptic peritoneal exudates, blood from an ectopic for instance, will give similar findings.

The blood-count in the patients in whom it was done during the early stage, showed leucocytosis with an increase in the polymorphonuclear count. Icterus was present in two patients early in the disease, and was therefore probably not due to pressure of the enlarged pancreas on the common bile duct, but rather to the same underlying condition which was responsible for the pancreatitis, namely temporary obstruction at the papilla, either in the form of a stone or spasm.

The diagnosis, though often doubtful, is made with increasing frequency, as judged by the more recent literature. In my series we were fortunate enough to make it with reasonable certainty in Cases I, IV, V, and VI, while in Case II, it rested between perforated gastric ulcer and pancreatitis and in Case III, we did not consider it at all, but made a diagnosis of cholecystitis. In this last case I believe the diagnosis could have been made, had we paid more attention to the left-sided pain and tenderness. The history is important, because most patients have had previous attacks of upper abdominal pain, which may have been mild attacks of pancreatitis or were caused by the existing cholecystitis or cholelithiasis. All my patients gave a history of previous attacks, and while some stated they had been different than the one for which they were admitted, others were under the impression that they were the same type but milder in character. We do know that the cases operated upon vary a great deal in regard to severity of symptoms and extent of lesion and it is therefore not difficult to believe that some attacks may be so mild that they subside without coming to operation. I have been interested in this question for some time and have made it a point to look for fat necrosis when operating upon the gall-bladder or stomach, but so far I have encountered only one patient, a man with a penetrating duodenal ulcer, who showed fat necroses without having symptoms referable to them or to pancreatic disease. Several years have elapsed since that operation and the patient has remained well. In one of my patients, Case IV, after making a positive diagnosis of acute pancreatitis, I was willing to test the question whether spontaneous cure was possible, but the symptoms steadily grew worse and operation became imperative. Acute pancreatitis is most often mistaken for cholecystitis, for peritonitis from a perforated viscus, or for acute intestinal obstruction, and it will not always be possible to differentiate between them. Bearing in mind however, particularly the difference between the intensity of the symptoms, and the slight distention of the abdomen, slight or no rigidity and the absence of obstipation, should at least make one think of acute pancreatitis, especially when the patient has been apparently healthy, is obese, and the attack has come on soon after

a heavy meal. Laboratory examinations are of little value. The vomitus and the fæces show nothing characteristic, and the blood examination will at most indicate that an acute condition exists. The urine may show a small amount of sugar, the presence of which may make us think in the right direction.

Treatment.—The general opinion among surgeons today is that the disease is a surgical condition, no matter during which stage it comes under observation. A study of the literature, and especially an excellent article by Körte show conclusively that operation during the early stage offers the best chance. In order to determine what we want to accomplish by an operation we must know what are the most likely causes leading to a fatal outcome. There are various opinions on this subject and it is possible that several causes work together. Some authors attribute death to shock or hemorrhage, others believe it is due to the sudden throwing out of function of an important gland. The most popular theory is that it is due to poisoning of the body by decomposition products of the pancreas or a toxæmia produced by fat necrosis. That the exudate in the peritoneum and retroperitoneal tissue is toxic, and is chiefly responsible for the general symptoms is demonstrated by many cases in which nothing was done but to sponge out this exudate, and recovery followed. To accomplish this is therefore one of the objects of the operation. It is also believed that the tension in the pancreas and peri-pancreatic tissue is partly responsible for necrosis of the gland. Relief of this tension during the early stage of the disease may therefore inhibit or limit the amount of necrosis. Such relief of tension can be brought about by splitting the fat overlying the pancreas or even entering the pancreatic tissue if areas of softening are present. Hemorrhage may be controlled or at least the hemorrhagic exudate may be drained instead of allowing it to spread into the retroperitoneal tissue, for it is probably the pressure on, or the penetration of the sympathetic ganglia by the exudate, which produces shock. It is seen therefore that an early operation is able to counteract almost any of the possible causes of death.

The best approach is through the median or right rectus incision. Large sponges are at once inserted to absorb exudate and prevent spreading it into the lower abdomen which is usually not involved. The exudate is then sucked or sponged out and the upper abdomen explored. I have approached the pancreas in my cases through the gastro-colic omentum, it gives good access and allows of good subsequent drainage. If the pancreas does not look or feel badly diseased, one may be content to insert gauze tampons into the retroperitoneal space for drainage. Usually however it is well to split the fat overlying it, bluntly and then insert the gauze tampons directly to the pancreas. The steps so far carried out have removed the free exudate, have relieved the tension in the gland and by draining the retroperitoneal tissue have produced favorable condition for carrying the toxic exudate outward, instead of allowing it to spread further into the tissue. One may

end the operation here, or devote some attention to the associated conditions. All of my cases had gall-bladder involvement. The question arises what to do with these associated lesions. My belief is, that if access is good and the patient's condition warrants it, one should remove the gall-bladder at once. The reverse being the case, it is better to postpone the gall-bladder surgery to another date. What I actually did do in the five patients on whom I operated was to leave the gall-bladder alone in two cases, both recovered, but one subsequently had to be operated on. In one patient I removed the stones and drained the gall-bladder, she also recovered. In the other two patients I removed the gall-bladder, one recovered and one died. However, death was not due to this, but to the fact that the patient had a most extensive hemorrhagic type of pancreatitis of which she died a few hours after operation.

Prognosis.—The prognosis depends on the amount of damage done, the intensity of the toxæmia, and the time at which operation is performed.

There is ample evidence that patients may recover from the acute attack without operation and develop one of the late sequelæ, such as pseudocyst, abscess, or necrosis. The treatment of all these conditions is surgical. I believe that if the entire pancreas is at once extensively involved as my Case I was, there is very little hope for the patient, unless drainage and relief of tension are instituted very early. If only a portion of the gland is involved, the prognosis is better, especially if the tail instead of the head is involved. In my two patients who discharged a necrotic slough about three weeks after the onset of the acute disease, it was the tail-end of the gland, which was discharged.

Once operated on for pancreatitis, are the patients likely to develop another attack? Theoretically one would say that if the predisposing factors continue to operate, there is reason to believe that subsequent attacks may follow. It will therefore be well to pay attention to the associated gall-bladder disease, either at the time of operation, or subsequently. Several recurrences have been reported in the literature. My own patients have remained well, seven, two, two, and one and a half years after operation.

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POST-OPERATIVE STRICTURE OF THE COMMON BILE DUCT

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THE bile ducts are lined by a single layer of tall columnar epithelium which is supported by a rather thick layer of elastic tissue. Then comes a layer of muscular fibres, and finally fibrous tunic. Scattered through the wall of the duct and communicating with its lumen are numerous simple tubular glands. The lining epithelium is possessed of extraordinary powers of regeneration and quickly covers any break in its continuity; in fact it grows into and lines a new duct constructed from other tissue, as was shown experimentally by Horsley. Injury to this layer of epithelium, whether by trauma or infection, probably is not of much consequence. The layer of elastic tissue which might be called the submucosa contains the real strength of the duct wall and permits of wide dilation. Injury to the submucosa by trauma or infection, and its replacement by fibrous tissue, represent the basic process of the pathology of stricture formations. A stricture can be lined by normal epithelium.

Instances of stricture of the common duct, independent of disease of the gall-bladder or stone in the duct, have been reported, but are exceedingly rare. Many cases spoken of as post-operative stricture are improperly designated because in the majority either the stricture itself, or the lesions which later developed into stricture, was present at the time of operation. True post-operative stricture is a sequel of operation in the same sense as post-operative hernia. According to this conception of the condition, the greater percentage of strictures of the common duct following operation on the gall-bladder or ducts, is caused by operative trauma.

We have collected from the records of the Mayo Clinic forty-eight cases of stricture of the bile ducts, and from this group we have selected for the present study ten cases in which the symptoms appeared in not less than six months after operation on the biliary tract. The interval of six months was arbitrarily chosen, because a lesion existing at or before operation and likely to develop into stricture would probably become manifest as a stricture within six months. It is possible that some of our cases are not cases of true post-operative stricture, as we have previously defined the term.

Injury to the ducts during cholecystectomy is an accident dreaded by every surgeon. Immediate recognition of the mistake is mortifying, but not necessarily alarming because repair usually can be easily and satisfactorily made. When the injury escapes the attention of the surgeon, nature proceeds with repair, but the handicap may be too great and stricture is then prone to follow; a persistent biliary fistula or intense jaundice signal the onset of serious trouble.

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Undoubtedly many instances of injury to the ducts occur which go on to spontaneous repair, and never give rise to symptoms.

It is difficult to determine what degree of injury is required to produce a stricture with symptoms. In many strictures which we have seen there was a lumen that permitted the passage of bile, but periods of recurring inflammation in the stricture gave rise to attacks of biliary obstruction, as evidenced by colic and jaundice. Occasionally there is a stone above the stricture which may be the cause of intermittent obstruction.

Many factors which predispose to injury of the ducts are well known, and it will suffice here merely to mention a few of the more important, such as anomalies of the ducts and vessels; traction on the pedicle of the gall-bladder, especially when removal is begun at the fundus, thus producing angulation of the common duct; and blind grasping with forceps for a bleeding cystic artery. The crux of the situation is failure accurately to identify the cystic duct. If the presence of inflammatory exudate around the pedicle of the gall-bladder or other conditions make definition of structures doubtful, it is certainly an act of better judgment merely to drain the gall-bladder rather than to jeopardize the welfare of the patient by persisting in efforts to carry out cholecystectomy. When the gall-bladder is distended by fluid or stones, or both, the region of the cystic duct is often inaccessible. A complete operation, that is, cholecystectomy, can be safely carried out in many such cases by first emptying the gall-bladder with the aid of a trocar or scoop.

Oddi was the first to show that the stump of the cystic duct dilated after cholecystectomy. His observation was confirmed by Haberer and Clairmont. Eisendrath and Dunlavy conducted similar experiments with identical results, and they also report two clinical cases in which small calculi were found in the stump of the cystic duct, and presumably were responsible for the patient's symptoms. Hartman, Smyth, and Wood have recently reported, as the result of their experimental work, that the stump of the cystic duct hypertrophies, not merely dilates, and takes on the appearance of a new gall-bladder: nature's compensation for the one removed by the surgeon. In the foregoing experiments particular efforts were made to leave as much of the cystic duct as possible, and the results have been used to influence the surgeon to remove the entire cystic duct flush with the common duct when performing cholecystectomy. We believe that this is misguided enthusiasm and will result in more harm than good. It is unwise, for obvious reasons, to leave the entire cystic duct, perhaps with a portion of the neck of the gall-bladder, after cholecystectomy, but, on the other hand, efforts to remove the entire cystic duct often result in excision of an oval piece from the wall of the common duct or inclusion of a portion of the wall of the duct in the ligature; a stricture usually follows. To leave a small stump of cystic duct sufficient to insure the integrity of the common duct is, we believe, the safest procedure, and one which will rarely give rise to future trouble. The cystic duct usually is involved in disease of the gall-bladder, and the stump would, therefore, be unlikely to undergo hypertrophy.

Incision of the common duct for removal of stones, for drainage, or for exploration, is rarely a cause of stricture. Cases in which cicatricial stenosis followed operations on the duct are usually ones in which calculi were removed, and in all probability the damage to the duct wall incident to the presence of calculi is the cause of the stricture. In four of our cases in which stricture developed, stones were removed from the common duct, and in three of these a biliary fistula persisted for several months; this was probably an indication of beginning stenosis of the duct. Incision of the duct is usually made in its long axis because it affords the best exposure. Transverse incision is probably equally safe, so far as stricture formation is concerned, but it is not so useful. Drainage of the duct by the T-tube, introduced by Kehr, is still used by Deaver and others with satisfactory results. Catheter drainage by the Robson method is also satisfactory.

It is difficult to explain the occurrence of post-operative stricture when cholecystectomy has been performed for simple chronic cholecystitis without stones and no apparent disease of the ducts, and when subsequent operation shows a stump of cystic duct with no evidence of injury to the major duct. A very probable explanation, we believe, is a localized infection of the glands of the wall of the duct which has resolved with the formation of fibrous tissue.

Symptoms of Stricture.—The time of onset of symptoms is variable. One patient was well for three and one-half years following cholecystectomy, then began to have colics with jaundice. It is possible that this lesion had no connection with the former operation. It is a significant fact that four patients stated that, following removal of the gall-bladder, a biliary fistula persisted for several months. There was probably partial obstruction of the duct at that time. When the fistula closed the patients remained well for several months, and then developed symptoms of obstruction. One might suppose that a stricture, when it begins to cause trouble, would do so by producing more or less complete biliary obstruction. This was true in only four of our patients. (One had constant jaundice and attacks of colic; one had a total biliary fistula; one had intermittent jaundice with opening and closing of a biliary fistula; and one had permanent jaundice.

The usual symptoms are those of intermittent biliary obstruction, that is, attacks of colic with jaundice such as occur with common duct stone. Four patients had attacks of severe colic and jaundice; and one had intermittent jaundice without pain. There is an apparent analogy with the symptoms of urethral stricture. Probably a low-grade chronic infection is associated, which causes temporary œdema sufficient to close the lumen of the stricture. The harmful effect of stricture is, of course, interference with free drainage of bile and consequent impairment of hepatic function, the result of back pressure. It is also probable that the liver may be considerably damaged before obstruction is manifested by clinical signs. An important factor in the surgical risk of these patients is the long duration of symptoms of biliary obstruction before they seek operative relief. One patient was deeply jaundiced for three months; one had had a biliary fistula and attacks of cholangitis with jaundice for nine

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months, and one had had attacks of cholangitis with jaundice for eight months. The remaining seven patients had had symptoms of intermittent biliary obstruction for from two to forty-two months.

The usual location of the stricture is at the juncture of the cystic with the common duct. The involvement of this area might be due to the fact that it is the most common site of injury; it is the least dilatable portion of the duct; and it is very often involved by extension of inflammation from the gall-bladder and cystic duct. The stricture itself when encountered at operation appears as a fairly definite area of constriction from 0.5 to 1.5 cm. in length. It may be tubular and annular, or it may affect only a portion of the circumference of the duct. The lumen is definite, but very small. The duct above the stricture is markedly dilated, whereas the portion below often maintains its normal appearance.

Operation.—The most difficult part of the operation is to locate and identify the duct. The adhesions are usually very dense, but this may be favorable, since the operation can often be performed entirely extraperitoneally. The operation is most tedious, requiring time and patience. When a fistula exists, it leads directly to the stricture. Otherwise it is advisable to work through an incision close to the median line and to follow the gall-bladder fossa from its notch in the edge of the liver. As the site of the duct is approached, the use of a syringe and needle is a great help in the identification of the structure. It may be difficult to distinguish between the dilated duct and the portal vein. If patients are jaundiced or very sick, the best plan is to secure drainage of bile to the outside, thereby favoring resumption of hepatic function and subsidence of cholangitis. The stricture is divided in the direction of the duct, and a T-tube inserted, which should be kept in for several months. Permanent relief will be obtained in many cases. Sometimes, stenosis recurs when the T-tube is removed. The methods of operative procedure employed in this series will be found in the reports of the cases.

Results of Operation.—The condition, owing to its nature, entails grave surgical risk, yet without operative measures the outlook is absolutely hopeless. Patients who recover from operation usually have mild attacks of colic, with or without jaundice, for several months, or sometimes several years, and then completely recover. The long duration of biliary obstruction or infection before operation often results in biliary cirrhosis which is sometimes the basis for post-operative symptoms. At best, these are very difficult and tedious cases, and present what is probably the most formidable lesion of the upper abdomen.

SUMMARY

Post-operative stricture of the common duct is usually the result of operative trauma. It may also follow localized infection or necrosis of the wall of the duct. The symptoms may be those of permanent or intermittent biliary obstruction, and often suggest stone in the common duct.

The patients are very ill and are grave surgical risks because of jaundice,

cholangitis, and impaired liver function. The site of the stricture is usually at the juncture of the cystic and common ducts.

Operation should provide biliary drainage and restoration of the normal course of the bile.

Results of operation are fairly satisfactory, considering the hazard and technical difficulty, and the otherwise almost hopeless nature of the condition.

ABSTRACTS OF CASES

CASE I.—(A51191). A woman, aged fifty years, had had hepatic colics, sometimes associated with jaundice, for fifteen years. Cholecystectomy and removal of stone from common duct had been performed elsewhere seven years before. She remained apparently well for three or four years, and then had had a return of the attacks of colic and jaundice almost daily for the last month. Four months before, she had had several gastric hemorrhages and passed blood in the stool.

Examination revealed that the liver was markedly enlarged. At operation, April 3, 1911, the common duct was found to be strictured at a point where the gall-bladder had been removed. The duct was incised for 1.9 cm. and scoops passed into the duodenum. A McGuire drain was inserted. The patient died seven days later.

CASE II.—(A39253). A woman, aged thirty-one years, had had attacks of hepatic colic for two years. Cholecystectomy for chronic cholecystitis without stones had been performed at the Mayo Clinic, September 10, 1910. The patient was well for two years, then had recurrent attacks of colic and much soreness over the right upper quadrant of the abdomen. Jaundice followed one attack.

A second operation was performed June 13, 1913, for stricture at the juncture of the common and cystic ducts. The stump of the cystic duct was split down into the common duct, and a Robson catheter drain inserted. The symptoms were relieved for about one and one-half years when there was a return of pain and soreness in the right upper quadrant, gastric distress, chills and fever, and occasional jaundice. A diagnosis was made of cholangitis with partial biliary obstruction.

A third operation was performed April 3, 1915, for recurrent stricture of the common duct. The duct was split longitudinally from the dilated portion down through the area of constriction. Forceps and scoops were passed into the duodenum. A T-tube was inserted, one end going down into the duodenum, the other extending 2.5 cm. up into the hepatic duct. The patient was examined in the Clinic seven and one-half years later and was perfectly well.

CASE III.—(A39393). A man, aged fifty-six years, had had a cholecystostomy for stones elsewhere seven years before. A short time after the operation he had had attacks of colic; he was then in good health until two months before examination at the Clinic, when, following a severe colic, a fistula opened in the old scar and drained mucus. He had not noticed that the stools were white.

Operation was performed at the Clinic August 26, 1915, for stricture of the common duct, at the juncture of the cystic ducts. The gall-bladder contained stones, and there was one stone in a diverticulum of the gall-bladder which, by pressure on the common duct, had produced the stricture. The common duct below the stricture was normal. Cholecystectomy was performed. The stricture was incised and a T-tube inserted. The patient died two days after the operation, from renal insufficiency.

CASE IV.—(A125271). A woman, aged forty-six years, had begun to have attacks of sick stomach, with chills and fever, jaundice, clay-colored stools, and a feeling of pressure in the epigastrium in November, 1913. Operation had been performed elsewhere May 9, 1914, and an abscess near the common duct drained. A second operation was performed elsewhere June 17, 1914, and a stone removed from the ampulla of Vater. This was followed by a biliary fistula which was constant, and present at the time of her admission to the Clinic. She also had frequent attacks of chills, fever, and jaundice.

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At operation at the Clinic March 1, 1915, the patient was deeply jaundiced; the gall-bladder and duodenum were adherent, and a cholecysto-duodenostomy was performed. There were no stones. The biliary fistula was not disturbed. The patient had fair health for three months after operation; then had attacks of chills, fever, and jaundice with clay-colored stools. At operation at the Clinic September 30, a stricture of the common duct and a few small stones in the hepatic duct were found. The stricture was excised and the hepatic duct united to the duodenum, the anastomosis being made over a small rubber tube.

The patient was examined in the Clinic, April 18, 1917. She had been apparently well for ten months after the last operation, and then began to have slight attacks of chills and fever. Jaundice was present. A diagnosis was made of biliary cirrhosis. A roöntgenogram showed that the tube used for the anastomosis was still in place. The patient died July 21, 1921.

CASE V.—(A142876). A woman, aged fifty-six years, had had gall-stone colics for fifteen years, and had been jaundiced in several of the attacks. Operation was performed elsewhere in June, 1914, and the gall-bladder drained for empyema. Jaundice, which was present at the time of operation, did not clear, and at a second operation six weeks later a stone was removed from the common duct. The jaundice cleared, but a biliary fistula persisted for five months. About two or three months after closure of the fistula, attacks of colic with jaundice and clay-colored stools recurred.

At operation at the Clinic, October 12, 1915, a very tight stricture of the common duct was found. The hepatic duct was united to the duodenum over a T-tube. The patient was not relieved, and died four months later.

CASE VI.—(A42032). A woman, aged forty years, had had a cholecystectomy performed elsewhere two years before. She was well for six or eight months, and then had a return of colics similar to those before operation. There was no history of jaundice.

At operation at the Clinic, September 29, 1915, the pelvis of the gall-bladder and the cystic duct, which had not been removed, were found to contain stones. There was a stricture at the juncture of the hepatic and cystic ducts, and an area of about 1.25 cm. had been removed from the anterior wall of the duct. The stump of the gall-bladder and the cystic duct were dissected out. A piece of the cystic duct with its mucosa was saved and sutured over the defect in the wall of the duct, thus uniting the hepatic and common ducts. Scoops had been passed into the duodenum. Seven years later, the patient reported that she was perfectly well.

CASE VII.—(A75971). A woman, aged forty-one years, had had attacks of severe epigastric pain for twelve years. She had never been jaundiced.

At operation at the Clinic in November, 1912, a thick, white gall-bladder was removed. There were no stones. The patient remained well for three and one-half years, and then began to have attacks of severe epigastric pain radiating to the back. Jaundice was present on several occasions.

A second operation was performed April 15, 1917, which revealed stricture of the common duct at the juncture of the cystic duct. The stricture was incised longitudinally, and then sewed transversely over a T-tube. The patient continued to have attacks of colic for two years after removal of the tube, but her last report five and one-half years after operation stated that she was in good health.

CASE VIII.—(A150805). A woman, aged forty-two years, had had attacks of gall-stone colic for three years; there was no history of jaundice. The gall-bladder containing stones had been removed elsewhere one year before. The patient remained well for about seven months, and then had a severe attack of colic followed by jaundice which persisted.

Operation at the Clinic, February 12, 1918, disclosed a stricture of the common duct at the juncture of the cystic duct. The duct below the stricture was apparently normal. There was no bile in the ducts. The stricture was incised and a T-tube inserted. The patient returned six months later and, while undergoing examination in the Clinic, developed an acute abdominal condition which at operation proved to be abscess of the liver. She was well for four months after this operation, and then began to have

recurring attacks of colic with jaundice and occasionally with fever. When she presented herself for examination there was definite jaundice.

At operation September 23, 1919, a stricture of the common duct was found. The side of the dilated duct above the stricture was united to the duodenum, the anastomosis being made over a short rubber tube. A report three years later contained the information that the patient vomited the tube one year after the operation. She is in good health, but occasionally is slightly jaundiced.

CASE IX.—(A39301). A woman, aged forty years, had had a cholecystectomy for cholelithiasis and appendectomy elsewhere in 1914. A stone was removed from the common duct elsewhere in 1917. This was followed by a biliary fistula for two months. Seven months after the fistula closed, the patient began to have attacks of hepatic colic with jaundice, sometimes with chills and fever.

Operation was performed at the Clinic, May 29, 1918, for stricture of the common duct at the juncture with the cystic duct. The stricture was dilated by opening the duct below it, and a Robson drain passed up through the stricture. Two months later the patient again began to have attacks of colic, occasionally with jaundice.

At operation performed June 19, 1919, it was found that the stricture had recurred at the former site. It was incised and the duct reconstructed over a T-tube. The tube was kept in place for three months, and following its removal, constant pain developed over the area of the liver, but no jaundice.

A third operation was performed July 14, 1920. The stricture had again recurred. It was incised and the duct reconstructed over a small rubber tube. The patient remained well for two years, but now reports a constant dull pain over the area of the liver.

CASE X.—(A315910). A woman, aged twenty-six years, had had a cholecystectomy for stones elsewhere three years before. This was followed by a biliary fistula which drained intermittently for several months and then remained closed. The patient had remained well until about eight months before, that is, about two years following the cholecystectomy. She then began to have attacks of chills and fever, vomiting and slight jaundice. There were no definite colics. The attacks were increasing in frequency.

Examination at the Clinic showed that the liver was definitely enlarged. A diagnosis was made of intermittent biliary obstruction with cholangitis.

Operation was performed May 21, 1920. There was an extensive stricture of the common duct and cirrhosis of the liver. Hepatico-duodenostomy was performed over a small rubber tube. The patient was examined four months later. She had had one attack of colic with jaundice. The X-ray did not show evidence of the tube. The liver was markedly enlarged. Attacks of chills, fever, and jaundice continued.

At operation May 4, 1921, the former anastomosis was found to be contracted and was producing obstruction, and another hepatico-duodenostomy over a tube was performed. A report received one and one-half years later stated that she had had several attacks of colic and jaundice.

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CHRONIC PARTIAL INTESTINAL OBSTRUCTION IN AN ADULT DUE TO ARRESTED DEVELOPMENT OF THE LARGE BOWEL*

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AND

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MRS. A. M. D., age twenty-seven, had suffered four years with manic depressive psychosis, the attacks of acute mania recurring at intervals of about ten months. The family history was entirely negative.

Past Medical History.—The patient had had most of the usual childhood diseases; the history otherwise was negative until the age of fourteen years, when there was an attack of acute appendicitis, which subsided promptly, and an interval appendectomy was done. Complete reports of this illness are not available; the abdomen was opened through a McBurney's incision and its cavity was not explored, but the appendix was said to have been found in the left side. Recovery from this operation was uneventful.

About the age of puberty an enlargement of the thyroid gland developed and persisted, gradually increasing in size. Thyrotoxic symptoms finally became manifest, and the gland was subtotally removed in April, 1922. The pathological diagnosis was toxic adenoma. There was complete relief of thyrotoxaemia, which has not recurred, although the mental condition was not influenced.

Menstrual history—negative. Normal full term labor in April, 1918. There has been no other pregnancy. Child is at present in perfect health.

Present Illness.—Since childhood, and particularly since her appendectomy, the patient has been quite constipated. As the mental disease developed, it was soon noticed that one of the first symptoms of an approaching outburst of mania was the development of extreme and obstinate constipation, movement of the bowels being secured only through the medium of an enema every third day. This constipated condition improved very much as convalescence became established, but never disappeared. It had also been noticed for years that the patient suffered more or less constantly from a pain of obscure origin in the right lumbar region. This was considered to be neurotic, even though it was always worse just preceding a mental outburst, when the constipation was most severe.

After this relation of obstipation to the attacks of acute mania had been observed sufficiently often to give assurance that it was more than a coincidence, gastro-intestinal studies were undertaken. Dr. G. E. Pfahler reported that X-ray examination of the gastro-intestinal tract revealed no abnormalities down to the iliocecal valve. From this point on, there was an extreme dilatation of the colon, with ptosis and malposition of the hepatic flexure, associated with marked coprostasis. After forty-eight hours, the head of the opaque meal had not reached the rectum; after seventy-two hours a large portion of it was still retained within the colon. The large bowel was then completely filled with opaque enema, which confirmed the diagnosis of malposition and dilatation. Several quarts of fluid were introduced, with no feeling of discomfort or distention on the part of the patient.

Laboratory Examination.—Chemical examination of stomach contents and of the stools was negative. Proctoscopic examination showed that the lower sigmoid was widely dilatable, with an anemic mucosa. Blood chemistry, Wassermann, urinalysis, phenol-sulphonethalein tests for kidney function all were within normal limits. Basal metabolism was normal one year after thyroidectomy. Blood-haemoglobin averaged 90 per cent. Red blood cells from 4,300,000 to 4,500,000. White blood cells on numerous occasions were never increased and the differential count was normal.

* Read before the Philadelphia Academy of Surgery, April 7, 1924.

On the basis of the X-ray findings and the coincidence above noted between increasing constipation and mental outbursts, colectomy was decided upon and was performed October 2, 1923, by Drs. Robert G. LeConte and Walter E. Lee of Philadelphia.

Operation.—The abdomen was opened by a five inch incision through the right rectus muscle. All normal relations were lost. It was some time before the colon could be found. The cæcum was finally located in the true pelvis. It had an unusually long mesentery. Continuous with it was a twisted, looped and distended mass of bowel, all bound together with dense fibrous adhesions, which represented the whole of the normal ascending and transverse portion of the colon, which were absent from their usual position. The omentum was exceedingly fibrous and thickened, and so firmly adherent to the pelvic structures that separation of the adhesions was impossible. It was ligated and cut away and the whole mobile portion of the colon was removed, probably as far as the splenic flexure, or a little beyond. About three-quarters of the length of the large bowel was excised. The end of the ileum was joined to the sigmoid flexure by lateral anastomosis.

Pathological Examination.—The pathological examination of the specimen revealed no gross abnormalities. The epithelium was nowhere atrophic or ulcerated. Microscopically, the only abnormality was an excessive thickness of the muscular layer.

Post-operative Course.—From the surgical standpoint, the convalescence was exceedingly smooth. There was, as anticipated, a marked sedative effect from the operation for a short while, but at the end of ten days it was necessary to return the patient to the mental hospital from which she had come. Except for the sedative effect, the present attack of mania proceeded as usual, uninfluenced by the operation. For the first few post-operative days there were from 15 to 20 liquid stools a day, mostly involuntary. This number has gradually diminished until now there are one or two formed stools a day, entirely under voluntary control. Physically, the patient is much improved. She looks better than she has for years past, her color is healthy, and her complexion clear. She is entirely free of backaches, of which she complained almost constantly before the operation.

An X-ray examination made three months after operation showed the stomach and small intestines normal, with peristalsis normally active. At the end of 24 hours almost all the barium meal had been evacuated. The remaining portion of the colon is from time to time quite rapidly filled by reverse peristalsis, and after a variable period rapidly and completely emptied. An opaque enema distended the rectum, sigmoid, and the remaining pouch of the descending colon, and could be pressed back through the stoma into the ileum. Plates were taken but were not satisfactory.

Discussion.—This case raises several interesting questions. What connection, if any, was there between this pathological condition of the alimentary tract, the hyperthyroidism and the mental illness?

What was the actual state of affairs within the abdomen and what caused it?

The first question is not susceptible of a perfectly satisfactory answer. Sir Arbuthnot Lane,¹ it is true, considers intestinal stasis responsible for whole hosts of pathological conditions, from cold hands and feet and bad breath on, including Graves' disease, and advises colectomy for their relief; but few are willing to go as far as that.

Likewise the relationship between the intestinal stasis and the mental illness must be left an open question. Manic depressive psychosis is almost universally held to be *sui generis*; there is no essential pathology known except a faulty makeup. True, this conception is being questioned at the present day, but is not yet overthrown. Mental troubles do go with megalocolon, but as Hallez² says they are usually of the nature of a hypochondriacal depression.

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Whether in this particular case there were any relationships between intestinal stasis and mental disease must, I think, be left *sub judice*. No decision will be possible until the lapse of more time.

To the other questions a more definite answer can be given. The condition was evidently not true Hirschsprung's disease, for that is a dilatation of

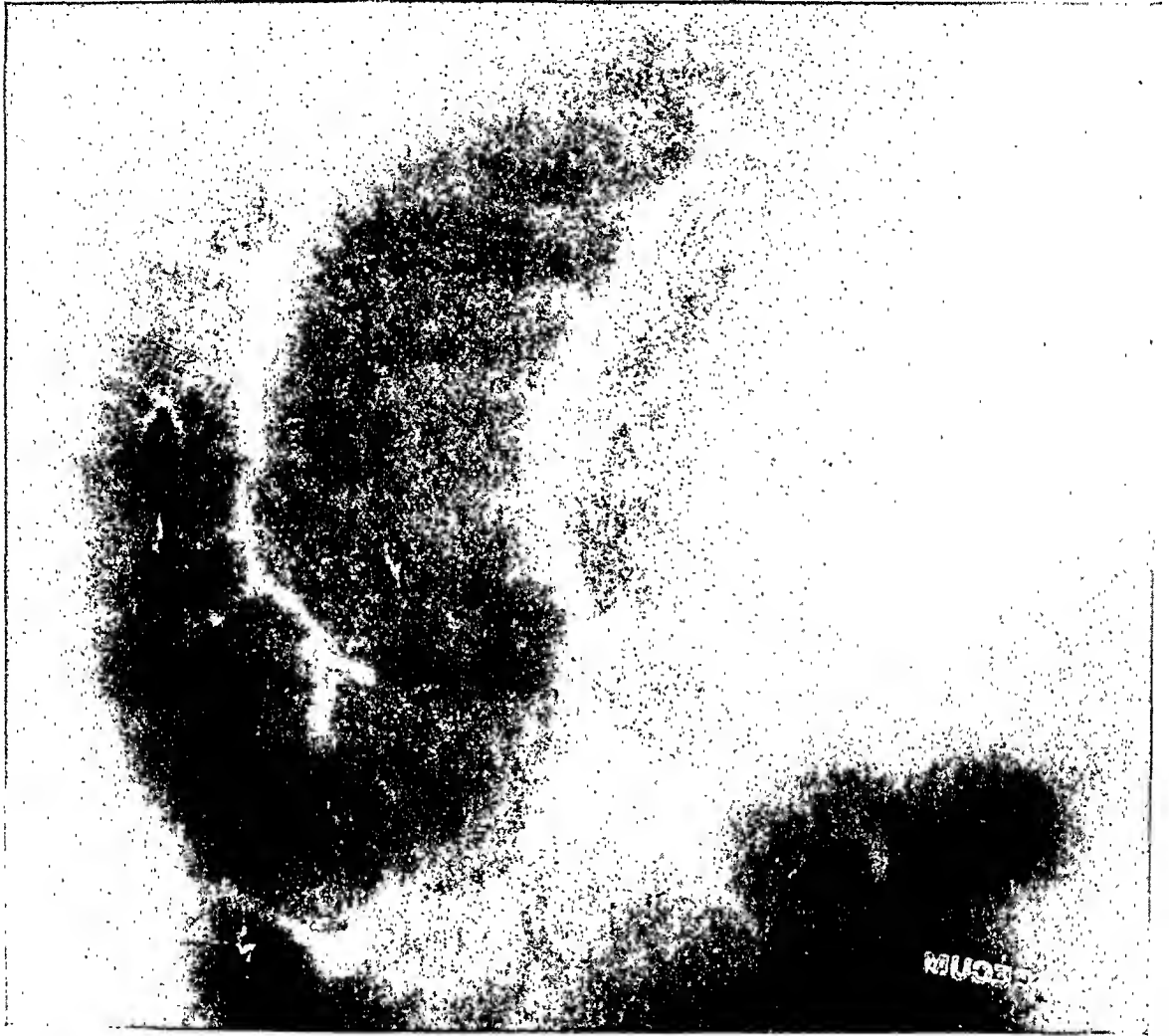


FIG. 1.—Röntgenogram showing distortion and malposition of colon. The greater part of the colon lies below the level of the iliac crests. Röntgenogram by Dr. G. E. Pfahler, of Philadelphia.

a normally situated colon and it is probably congenital, though urgent symptoms are sometimes late in developing.

Embryology of the Colon.—The fundamental fault in this case was an arrest of development, occurring in early fetal life—probably about the third month of gestation. It will be remembered that the primitive gut early forms a loop directed ventrad, with the vitelline duct at the summit of the loop. The first change that occurs is the formation of the anlage of the cæcum on one side of the caudal limb of the loop. The whole loop then twists about the superior mesenteric artery as an axis, until the cæcum lies under the liver; the entire gut is still connected with a common mesentery. The colon is then pushed out against the parietes by the developing coils of small intestines, until—about the fourth or fifth fetal month—the mesocolon fuses with the parietal peritoneum in the left flank, and across the spinal column and duode-

num, so that the duodenum pierces the transverse mesocolon. Then later, and more slowly, the cæcum elongates, and grows down along the right side of the abdomen, but does not reach its definitive position until several years after birth. In its course, the cæcum and its mesentery also normally fuse with the parietes.

In this long and complicated process of development from the simple fetal to the complex adult relation, an arrest of development is possible at any point. The most common fault is for the cæcum to fail to fuse with the parietal peritoneum, a condition resulting which is known as cæcum mobile. On the other hand, the fusion may progress further than normal and the whole cæcum and even the appendix be retroperitoneal. Very rarely the rotation may take place normally, but the mesocolon fail to fuse—a condition usually called mesenterium commune. Occasionally rotation may not occur at all, or only in part.

Bräunig³ discusses this subject in a most interesting article, although he gives a slightly different anatomical classification. He considers there are three degrees of failure of the gut to rotate properly. First, cæcum mobile, where rotation has occurred, but the ascending colon has failed to appear. Second, where rotation and fusion have taken place properly from the caudal end of the gut to the splenic flexure, but from there up has not occurred. Third, where there has been complete failure of rotation of the primitive gut, with mesenterium commune.

He quotes a case of the third degree of failure of development, which illustrates the subject very clearly, as ours illustrates the second degree. In Bräunig's patient, the head of the cæcum and the terminal ileum pointed cephalad; the continuation of the cæcum coursed into the true pelvis, which was filled with coils of colon, with no small intestines. The colon was attached to a long mesentery, and strangely, was provided with a well developed omentum. The junction of the cæcum and colon was not more than a finger's breadth separated from the junction between the colon and the rectum. Below the stomach was no transverse colon, only coils of small intestines; the greater curvature gave origin to a narrow great omentum, only two finger's breadth wide.

This case of Bräunig's shows complete retention of the fetal condition with entire failure of the primitive gut to rotate. The colon occupies its primordial position, caudad to the rest of the alimentary canal. Our case, on the other hand, is an example of the second degree of failure of rotation, for the relationship of the colon was normal below the splenic flexure. From this point to the cæcum the large bowel was found occupying the true pelvis, its primitive situation below the small intestines.

A curious circumstance, which I am not able to explain, is that both Bräunig's patient and our own had what was apparently a great omentum depending from the colon. The great omentum is entirely a gastric organ, formed from a pouching of the mesogastrium in the process of rotation of the stomach, and only secondarily comes in relation with the transverse colon at a comparatively late stage in development. Evidently, however, it subserves such an important function, whatever it may be, that if there is no great omentum attached to the colon, it is necessary for the organism to improvise one.

The case we report began to show symptoms of chronic constipation

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following her appendectomy in childhood. Until that time, the intestinal malformation had caused no symptoms; nor is there any reason *per se* why it should have caused any. Evidently the attack of appendicitis was more acute than was thought at the time; there was probably a certain degree of peritoneal irritation or true peritonitis which resolved spontaneously, but which left behind those crippling adhesions holding the colon firmly kinked and motionless, which was the actual cause of the chronic obstruction.

Summary.—A case is reported of early arrest of development of the alimentary canal. Superimposed on a simple malformation are the sequelæ of a former peritonitis, which kinked and bound the colon together in such a way as to result in chronic obstruction of mild degree. Associated, whether coincidentally or etiologically cannot be determined, is a condition of Graves' disease and of manic depressive psychosis. The embryology of the alimentary canal is discussed in explanation of the condition found.

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HEMORRHAGIC ULCER OF MECKEL'S DIVERTICULUM

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A CAREFUL search of the available literature failing to afford any reference to cases of repeated attacks of severe intestinal hemorrhage due to an

ulcer of Meckel's diverticulum, the following case report is presented as worthy of record.

W. E., a boy aged ten years, was first brought to the Clinic, March 4, 1912, because of repeated attacks of intestinal hemorrhage. Six months previously he had complained of a rather severe colicky pain in the left mid-abdominal region, accompanied by repeated vomiting at frequent intervals for forty-eight hours. The vomitus had consisted of mucus and bile. There had been no elevation of temperature. The boy had quickly recovered from this attack and apparently had remained well for three months. He then had, at intervals of one week, three quite similar attacks, the last of which was accompanied by severe intestinal hemorrhage. He had not complained of pain after the second day in this last attack nor had he vomited; he continued to pass blood from the bowel for three weeks; the loss of blood had been so severe that his life was despaired of. Since then he had had several prolonged periods of intestinal bleeding unaccompanied by the cramp-like pains of the earlier attacks.

During these periods he became extremely anæmic, with marked loss of weight and strength; but in the intervals he gained weight and strength quite rapidly, though the anæmia persisted to a more or less marked degree. The father had taken the child to

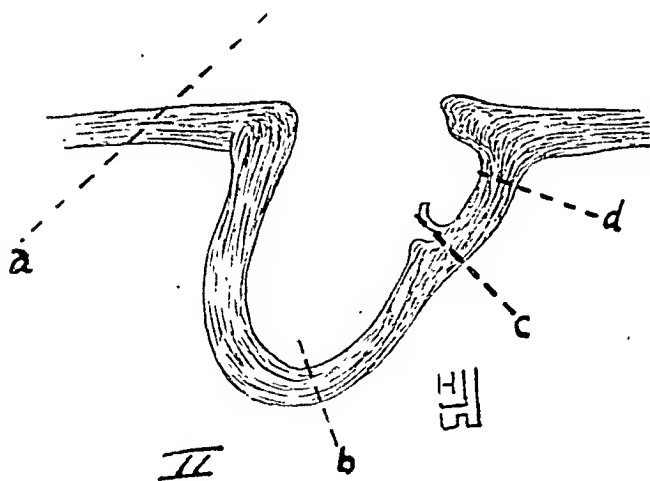
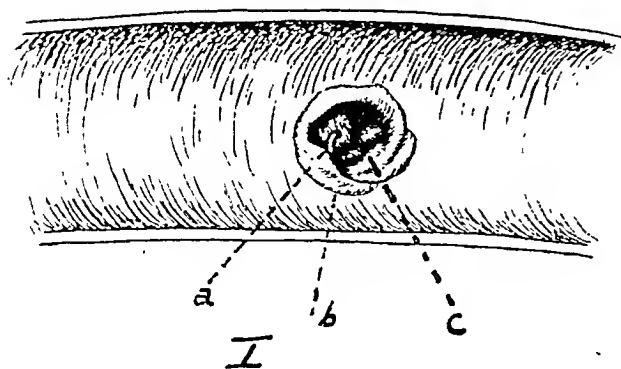


FIG. 1.—Ulcer of Meckel's diverticulum: a. artery; b. margins of opening into diverticulum; c. ulcer.

FIG. 2.—Ulcer of Meckel's diverticulum: a. lumen of bowel; b. the diverticulum; c. artery; d. the base of the ulcer.

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numerous consultants and at one time the boy had been under observation for two weeks in a large city hospital where a diagnosis was made of Henoch's purpura with hemorrhages from the intestinal mucosa.

A very appreciable improvement in the boy's condition had recently occurred, the anemia being much less severe; but the family lived in constant dread of his having another attack with a fatal intestinal hemorrhage. During the few days which the boy stayed in the hospital under our observation, an intensive study of the case failed to lead to even a tentative diagnosis. Physical examination did not reveal any abnormal condition in the chest or abdomen. Proctoscopic examination had been negative as had roöntgenograms of the gastro-intestinal tract.

January 14, 1915, the father again brought the boy to this Clinic. The history during the past four years proved to be a repetition of that given on the previous visit. At frequent and infrequent intervals the boy had had repeated attacks of severe intestinal hemorrhage. Some of the attacks had been initiated by cramp-like pain in the left mid-abdominal region. The hemorrhages had often come without warning and at times were so severe and lasting, and resulted in such marked anemia and asthenia, that the boy had become a chronic invalid.

The father had given up all hope of a definite positive diagnosis and had returned to the Clinic because the suggestion was given here four years previously that the case might be of a surgical nature and that if the hemorrhages persisted, an exploratory laparotomy, during a period when the boy was in fair condition, would be warranted. This opinion had been based upon the facts that:

1. A positive diagnosis of any true blood dyscrasia could not be demonstrated.
2. The attacks were often initiated by severe cramp-like pains definitely located in the left mid-abdominal region.
3. In the occasional prolonged intervals between the attacks the boy gained rapidly in every way and the blood picture became practically normal.

Although the patient was again thoroughly examined, we failed to find any evidence on which to base a diagnosis, beyond that of a probable surgical condition.

Operation.—Operation was performed under ether anæsthesia. A 10 cm. left mid-rectus incision was made to permit a thorough examination of the abdominal contents. The peritoneum was normal. Palpation and inspection of the rectum, rectosigmoid, ascending, transverse and descending colon failed to reveal any abnormal condition. The stomach and duodenum were normal, as were the liver and spleen. A great many palpable lymph-glands were found in the mesentery, the largest of these measured 1 x 1 cm. and some of them were calcareous. Beginning at the ileocecal junction, the small intestine was stripped between the fingers. A conical, indurated mass 6 x 3 cm. was found protruding from the ileum 50 cm. from the ileocecal valve; the base of the outgrowth was incorporated in the tissues forming the wall of the ileum in the manner characteristic of a Meckel's diverticulum. This Meckel's diverticulum was so indurated and chronically

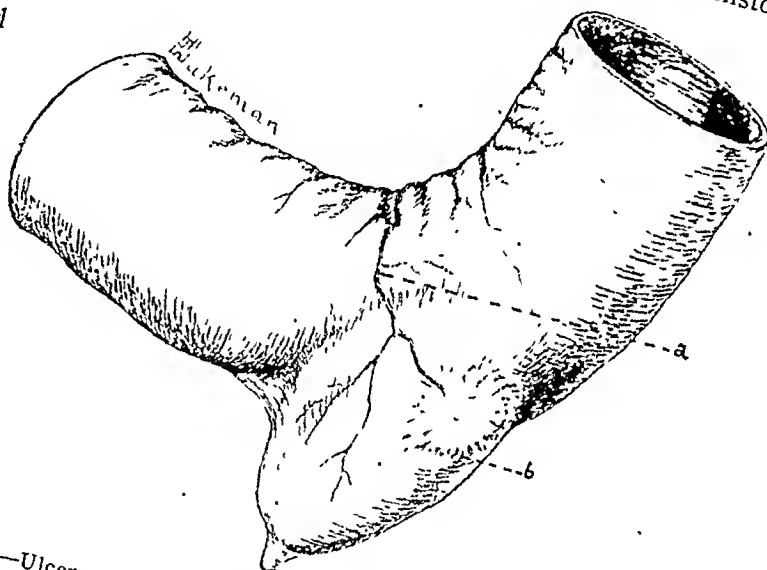


FIG. 3.—Ulcer of Meckel's diverticulum: a. omphalo-mesenteric artery; b. thick scar-tissue at base of ulcer.

inflamed that it was not possible to excise it and leave a patent condition of the bowel. The remainder of the small intestine was in all respects normal. A segment of ileum, 12 cm. in length with the diverticulum, was resected and a lateral anastomosis made with careful closure of the mesenteric gap.

Gross Examination of the Specimen.—The diverticulum was of the stumpy, conical type without any terminal ligament. On palpation, the wall was so indurated that it required considerable pressure to indent it. The maximum thickening was at the base of the distal side and continued on into the wall of the ileum for about one-half of its circumference in such a way as to diminish the lumen of the bowel to a considerable extent. A 20 degree angulation of the bowel on its mesenteric side was noted. During exacerbations of the chronic inflammatory process there would undoubtedly be sufficient encroachment on the bowel lumen to give rise to partial intestinal obstruction. By dividing the wall of the bowel opposite the diverticulum a very excellent view was afforded of the exciting factor of the patient's repeated intestinal hemorrhages. The walls of the diverticulum at its base were from 1 to 2 cm. in thickness and an indurated crater ulcer 1 cm. in diameter was situated in the thickest part of the wall of the diverticulum, partly in the margin where the ostium of the diverticulum begins, but four-fifths of it lying within the diverticulum itself. In appearance it resembled an indurated duodenal ulcer. The base of the ulcer was entirely bare of mucosa and at the margin of this area an eroded vessel, which looked like an artery, projected from the surrounding surface in an erectile manner. This particular vessel had undoubtedly been the source of the many hemorrhages. It was apparently a terminal branch of the omphalo-mesenteric artery which was found coursing on the surface of the diverticulum.

Subsequent History.—The boy made an uneventful recovery and has remained well. Unfortunately the specimen, which was sent to the pathologic laboratory of the University of Wisconsin, was mislaid and efforts to find it have thus far been unsuccessful. The presence of numerous enlarged lymph-glands in the mesentery of the small intestine, some of these glands being decidedly calcareous, would suggest that the ulcer might have been tuberculous in nature.

A METHOD OF HERNIOTOMY UTILIZING ONLY WHITE FASCIA

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THERE has been a steadily increasing recognition of the fact that our methods of curing inguinal hernia are far from satisfactory. The very fact that the literature is constantly full of new operations or modifications of old ones is suggestive. A study of the recurrence rate amply confirms our fears.

Prior to Bassini,^{1, 2} Wood,³ in 1886, reported 27 per cent. recurrences, and Bull,⁴ in 1890, 36 per cent. Both were ready to admit defeat and call hernia surgery a failure. Bassini's achievement of only 2.8 per cent. recurrences² gave surgeons a very exaggerated idea of the efficacy of his method. These concepts prevailed for about 20 years and we hear Murray⁵ claim 1.7 per cent. recurrences. Judd,⁶ 2.5 per cent., Bull and Coley⁷ 0.8 per cent., all just prior to 1910. We know now that such statistics meant nothing because they were not arrived at by proper follow-up methods. Since then the impression has grown that all was not well and the publication of series of actually traced cases have changed our optimism to pessimism. The following three series, from the Massachusetts General Hospital, Bellevue in New York and Johns Hopkins respectively, are representative of results in America. Similar figures are available in the foreign literature.

Davis ⁸	9 per cent.
Erdman ⁹	7.5 per cent.
Taylor ¹⁰	10.9 per cent.

(The following references in the bibliography contain a series of traced cases and if consulted will dispel all doubt that the above figures have a very general application.)

Davis,⁸ Erdman,⁹ Taylor,¹⁰ Schwartz,¹¹ Ricketts,¹² Galeazzi,¹³ Oudarde and Jean,¹⁴ Russell,¹⁵ Lameris,^{16, 17} Masson,¹⁸ Salzer,¹⁹ Hoffman,²⁰ Murray,⁵ Murphy,²¹ Fantine,²² Bassini,² Harrison,²³ Downes,²⁴ Bloodgood,²⁵ Esten.²⁶

This growing dissatisfaction with the results of our work is shared by almost all students of the subject except one—perhaps our greatest—Coley. His yearly reviews in "Progressive Medicine"²⁷ reveal a complacency and decided feeling of satisfaction with the Bassini type of operation. However, allowing for his enormous experience, which none of us can ever hope to equal (nearly 10,000 cases in 1924),²⁸ it is only reasonable to call attention to the great preponderance of children in his material and the corresponding scarcity of large hernias and direct ones. His own estimate of his recurrence rate, 2 per cent.—3 per cent. is not based on follow-up reports and one cannot doubt that it would correspond to a far higher one in more difficult cases. For recurrences in children, see Kovacs,²⁹ one recurrence in 144 traced cases; Salzer¹⁹ none in 50 traced cases; Stiles,³⁰ 360 cases, 4 recurrences. Sultan,³¹

Ochsner,³² and many others have noted a low recurrence rate in children. Murphy,³¹ in a very elaborate analysis, reports a gradually increasing rate from 1 per cent. under one year to 9 per cent. in patients over 60.

All the above material represents the results in the foremost clinics and for the most part omits strangulated hernias and unusual ones and hence it is reasonable to suppose that less experienced operators have still worse results. We must face the fact that herniotomy is one of the operations most commonly done by the beginner in surgery.

A more detailed study of the causes of recurrence^{8, 9, 10} reveals the significant fact that these failures cannot be passed off as unavoidable infections. To be sure sepsis accounts for many, but in no clinics do infection occur in any such numbers and itemized reports leave no doubt that the majority of failures can only be attributed to faulty planning of our operations. Any contemplated change in our methods must consider two factors, one very old and the other rather recently brought to light.

(1) *The Endo-abdominal Fascia*.—So many names have been applied to this unit structure that the utmost confusion reigns as to just what it is. Not only have sage anatomists changed its name for every region of the belly but even in the inguinal region no agreement seems to exist. Be it called endo-abdominal, transversalis, verticalis inguinal, iliac or what-not, it is all the same to the surgeon, who in every other laparotomy would never dream of omitting to close it. A hundred years ago when such surgeon-anatomists as Cooper³³ and Scarpa³⁴ made beautiful dissections of hernias they understood clearly that one of the most important elements in the pathology of hernia was the giving away of this fascial envelope of the belly. In some cases the hole for the exit of the cord was unduly large. In others the portion next to Poupart's ligament had simply been thinned out and stretched. Much discussion occurred as to whether this was a cause or effect of hernia. Our present knowledge of the wholly congenital (saccular) origin of the disease (Coley *et al.*³⁵ and Russell³⁶) leads one to suspect that this deficiency is also congenital. Operative findings in children also tend to support this view. Mere calling attention to the fact that at this point strangulation nearly always occurs, is ample proof that this is the real internal ring and that the abdominal muscles have nothing whatsoever to do with the internal ring.

Older surgeons, such as MacEwen,³⁷ of Glasgow, and Marcy,³⁸ of Boston, planned their operations with this structure clearly in mind. Then, when in 1889, Bassini made Padua the Mecca of all herniotomists, the attention of every one was rivetted on the conjoined tendon as the real structure to be used in the closure. That so many writers forgot his teaching was no fault of his, except in so far as he relapsed into the deepest silence. A surgeon, E. Wyllys Andrews,³⁹ who visited his clinic and described his exact technic ("The Bassini operation as done by Bassini himself") spoke as follows:

"Now the dissection of the peritoneum away from the internal ring
* * * has also had the effect of loosening the transversalis fascia and internal

HERNIOTOMY UTILIZING ONLY WHITE FASCIA

oblique muscle * * *. These as every one knows are the structures to be included in the Bassini operation in the first or deep line of suture, intended to restore the enlarged ring to its normal size. To facilitate the insertion of these stitches a forceps is made to grasp the transversalis and internal oblique, pointing from the internal ring inward, one blade just outside the peritoneum, *i.e.*, the blades grasp the whole of the posterior wall except the peritoneum."

Bouveret,⁴⁰ a contemporary, in describing Bassini's operation, published

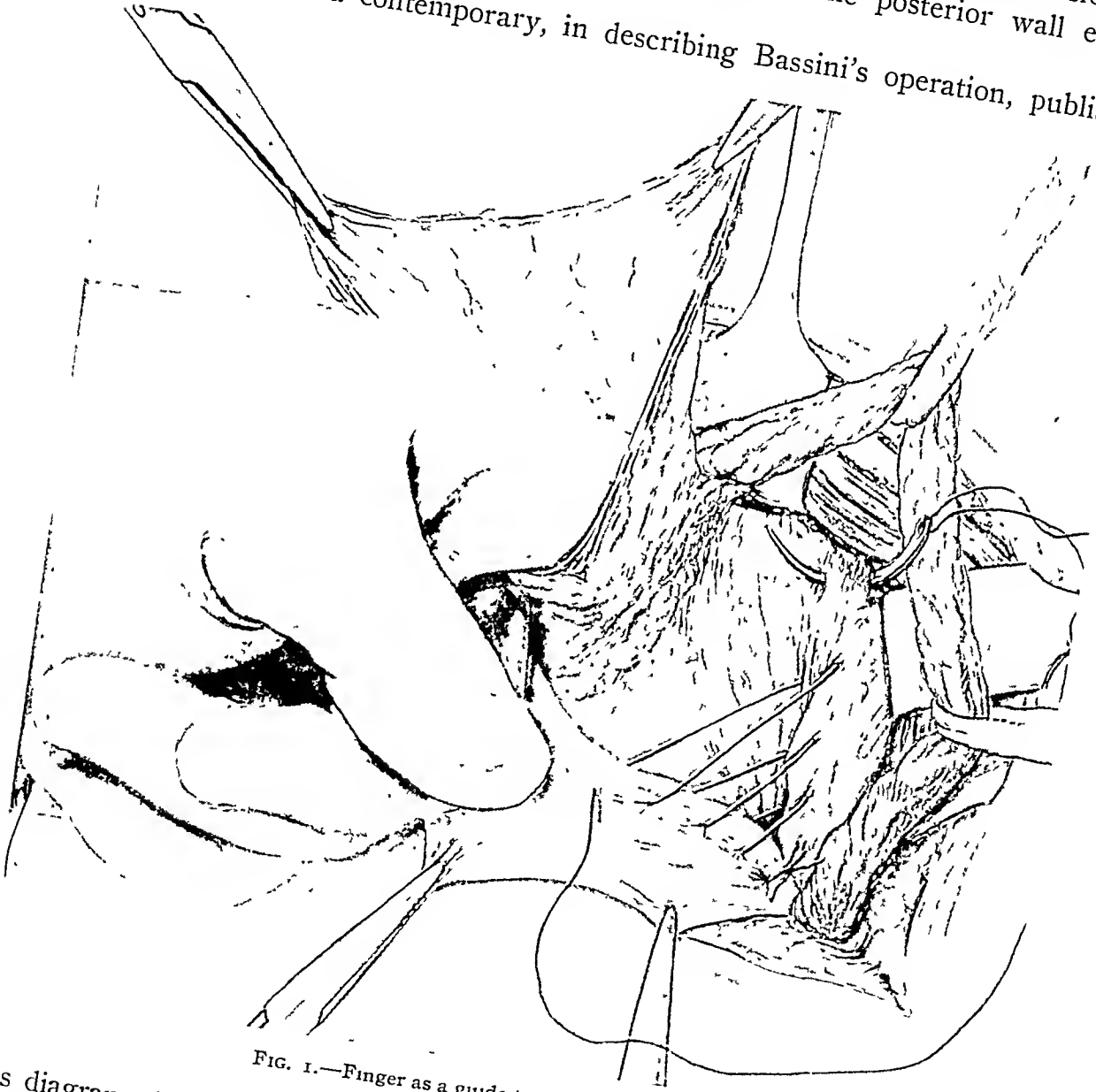


FIG. 1.—Finger as a guide to outline deep ring.

this diagram showing clearly the recognition of the necessity of closing the hole in the endo-abdominal fascia. (Fig. 1.)

It goes without saying that in the vast majority of clinics the Bassini operation is most emphatically not done in this manner any longer, although recently Pitzman,⁴¹ LaRoque,⁴² Druener⁴³ and others have described methods, some admirably designed to correct this defect in our technic. Even now it is clearly recognized that the most efficient way to close a hernial ring is from within. If one is performing any other laparotomy in the neighborhood, a few

stitches in the peritoneum and fascia are far more effectual than any other type of herniotomy. One has the feeling that he is really sewing up a hole and not going through the motions of a complicated plastic operation. The question remains, however, even if the Bassini operation were properly done, is it anatomically and physiologically correct?

(2) *Use of Red Muscle a Mistake.*—It is a commonplace that in a Bassini operation our inner row of stitches are in red muscle, not in tendon. The conjoined tendon as seen in the dead house simply does not exist in men with hernia in most cases. Bloodgood,⁴⁴ Blake,⁴⁵ Hessert,⁴⁶ and many others have emphasized this fact. Polya⁴⁷ showed clearly that the lower fibres inserting onto the pubis are absent in hernia patients and the insertion of the lowest fibres was onto the lateral edge of the rectus sheath, averaging 2-3 cm. above the bone. He measured 100 consecutive cases of hernia with the following results:

Polya.—Length of rectus bordering inguinal canal.

Cases	Cm.
1	0
7	1
31	2
28	3
17	4
9	5
5	6
2	7

Ferguson⁴⁸ demonstrated that a similar condition existed at the lateral end of the canal and that in men with hernias the origin of the internal oblique was farther out on Poupart's ligament. It can then be definitely assumed that the red muscle bordering the canal lies at a considerable distance from the inguinal ligament and can therefore only be approximated to it under considerable tension, especially near the pubic spine. The doubt at once arises, can it be made to adhere to Poupart's?

Oudarde and Jean⁴⁹ studied 183 recurrent hernias operated upon in the French Navy. In practically every case the red muscles had pulled away from the inguinal ligament. Moschcowitz,⁵⁰ Polya,⁵¹ Walker,⁵² Harrison⁵³ and Lusk⁵⁴ have published similar observations and all surgeons who have operated upon many recurrent hernias will vouch for the truth of such statements. Until recently this separation of red muscle from Poupart's was thought to be the cause of the recurrence. We are now being compelled to face the fact that such a union never occurs. The most that can be hoped for is the creation of a thin layer of scar tissue between these structures.

McNealy⁵⁵ has observed several old herniotomy wounds at post-mortem. He finds that the red muscle pulls away in all cases even though no new hernia occurs. I have had the opportunity to make one similar observation ante-mortem. This occurred in a young man who had been operated upon for cryptorchidism about one year before. There was no recurrence of the

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hernia but the testicle had retracted into the canal again. I found that, although the posterior wall of the canal felt firm and resistant, the margin of the internal oblique was nowhere in contact with Poupart's ligament where it had been stitched by the previous operator.

Seelig and Chouke⁵⁶ attacked this problem experimentally in a very clever manner. By making a curved incision in the fascia lata of a dog and reflecting the flap, a sharp edge can be produced similar to that of the inguinal ligament. They sutured this

to the underlying muscles and found that in every case the stitches promptly cut through and no adhesion was created. Silk suture lasted only a few days longer than catgut. The only agent capable of producing real adhesion was extensive infection, an agent whose aid surgeons would scarcely solicit. They also called attention to the fact

that such a union had no parallel in other normal structures and that theoretically one would not expect it to occur. Dowd⁵⁷ seems to have had a similar thought in 1914 and Druener⁴³ in 1919.

Not only theoretical and experimental observations are available as proof of this point. Clinical experience of many surgeons may be added. Hull,⁵⁸ Hoffman,²⁰ Salzer,¹⁹ Pitzman,⁴¹ and Lameris¹⁷ have had the courage to abandon the red muscle suture and the results have amply warranted their daring. There are now on record over 2000 herniotomies consisting solely of sac removal which were followed up and reexamined. The recurrence rate is slightly less than that of comparable series done by standard methods. Furthermore, it is now being done as a routine in many European clinics and further information will soon be available.

It is not enough to demonstrate the uselessness of internal oblique suture. On that basis alone conservative surgeons may argue that it might conceivably be of value and should therefore be retained. Can we say that it is positively harmful? First let us consider the function of this muscle. In a normal man the lowest fibres have a definite sphincter action. They arise from Poupart's

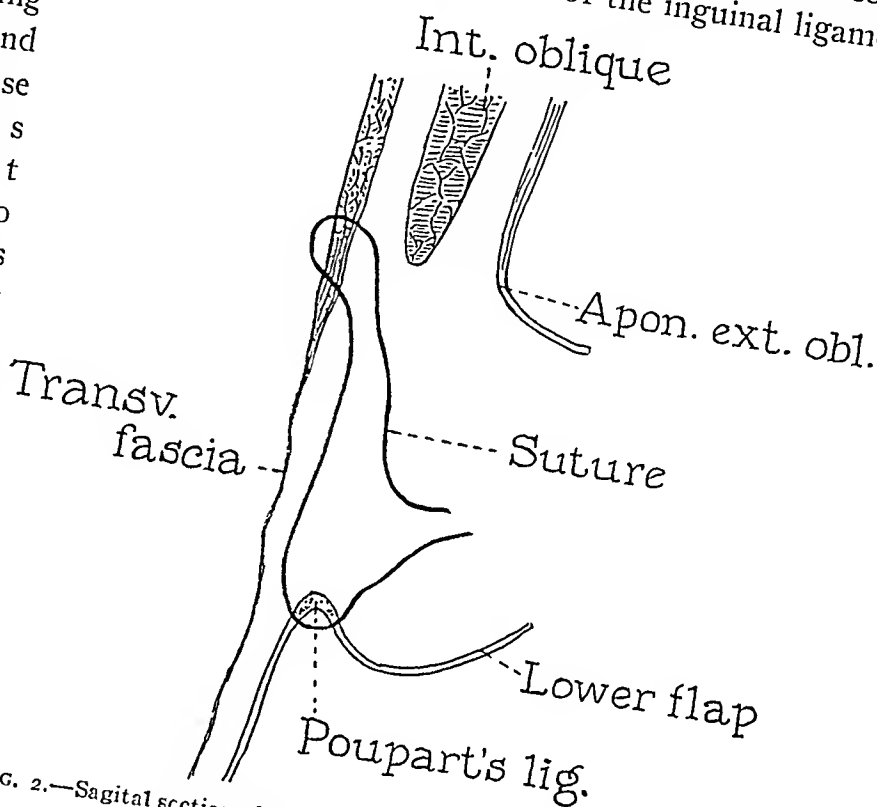


FIG. 2.—Sagittal section of layers showing deep suture placed beyond thin edge, thus obtaining a strong layer.

and insert just beneath it on the pubis. Contraction of these fibres will approximate them to the ligament. This has been compared to the shutter action of a camera by Keith.⁵⁹ It is strictly comparable to the sphincter ani externus, except that it represents only one-half of it, the other half being a solid structure. In neither case are circular fibres necessary to accomplish sphincter action. The cremasteric fibres represent the internal circular sphincter. The weakness and inefficiency in man is evident but it is interesting to note how they hypertrophy under the stimulus of attempting to retain a long standing hernia.

In nearly all animals except man the patent tunica vaginalis persists throughout life but inguinal hernia is rare because of this sphincter action. In rodents the testes pass freely back and forth from the abdomen to the scrotum in response to physiological conditions but even this constant distention of the canal is counteracted by the sphincter action of the cremaster. This is called the cremaster externus in animals and is a well developed circular set of fibres. Even the larger herbivora with the enormous intra-abdominal pressures common on such diets (hay-belly) are thus able to protect wide open hernial sacs.

In discussions of the etiology of hernia in man one often hears that the upright position is to blame. To this ruinous primate blunder has been attributed every bodily ill from colonic stasis to flatfoot but I doubt if any wilder absurdity has been perpetrated than to ascribe to biped locomotion a disease occurring most commonly in infancy.

Of course any modern speculation on the etiology of hernia must include the preformed sac. But anatomical records point unmistakably to the fact that most men with preformed sacs never get hernias. About 35 per cent. of three months old infants have potential hernia sacs, (Murphy);²¹ in middle age they are found in 23 per cent. of cadavers (Eccles);⁶⁰ and Keith⁵⁹ found 12 per cent. in the very aged. In the latter figures inguinal sacs are in a majority, umbilical and femoral ones predominating. Compare these figures with the incidence of hernia. About one in sixteen born will acquire hernia (Berger).⁶¹ Why do not all these potentially ruptured become actually so? The answer is the same as in the case of the lower animals. We have our cremaster as one guard and the internal oblique as a second. The first is admittedly weak. Consider now an internal oblique with the lower fibres absent as noted above. (Table II.) It has only one end attached to poupart's, the outer. The inner end is 2-3 cm. away on the rectus sheath. Its efficiency as a sphincter is seriously impaired. The condition is again parallel to a sphincter ani. If during childbirth the anterior ends of the rectal sphincter are separated from each other, its mechanism is ruined. Repair consists simply in bringing them together again. No actual destruction of muscle has occurred. This anal sphincter consists simply of the medial fibres of a much larger muscle, the levator ani. So the inguinal sphincter consists of the lower fibres of the internal oblique.

The lowest fibres are the ones that count and their destruction by ill

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advised suturing will utterly wreck the inguinal sphincter. Whether such sutures cut off the nerve filaments to the lowest fibres cannot be positively stated but the studies of Dowd⁶² and Moschcowitz⁶³ leave considerable doubt on this score. What other explanation can be offered for the fact that about 4 out of 7 recurrences in oblique hernia are not oblique but direct and come



FIG. 3.—Transversalis fascia instead of red muscle in deep suture.

out just above the pubic spine? (Burian,⁶⁴ Fantino,²² Masson,¹⁸ Erdman.⁹) The only possible interpretation is that in these cases our stitches in the lower end of the canal have not only failed to strengthen it but instead have brought about hernia formation where none existed before. As has been amply demonstrated, simple sac removal will cure most hernias.

EFFECTS OF THE INTRAMUSCULAR INJECTION OF SODIUM CITRATE UPON BLEEDING*

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Historical Review.— In 1915, sodium citrate was first used clinically to prevent coagulation of blood in transfusion operations. Being recognized as an anticoagulant, the question logically arose: would the introduction of the citrate suspend coagulation of the recipient's blood? This did not occur, as was soon established: in fact only a transient shortening of the coagulation time of the recipient was found to follow transfusion of citrated blood. Neuhof carried out some experiments along this line in 1916 consisting of the intravenous injections of solutions of sodium citrate into dogs under ether anæsthesia. The following results are quoted:¹

“(1) The coagulation time is tremendously shortened within a few minutes after the introduction of non-toxic doses of sodium citrate, and this shortened coagulation may be sustained for one or more days; (2) The bleeding time is likewise shortened so that, after citrate injection, a large vessel can be incised with prompt coagulation about the wound; (3) Coincident with the shortened coagulation time, the color of the venous blood is altered to a light arterial tint. (4) There is no fixed toxic or lethal dose of sodium citrate per kilo of body weight, toxicity depending to a remarkable degree upon the rate of introduction of the citrate solution. (5) A toxic or lethal dose is characterized by a swing from the state of shortened coagulation to one of suspended coagulation. This latter phenomenon led to the sodium citrate method of blood transfusion, and it was this effect which overshadowed the ordinary pharmacological action of sodium citrate.”

Observations on the intravenous injection of sodium citrate on the human being have been few and far between. Weil² in 1915, reported shortening the coagulation time one-half by the administration of 5 gms. of a 20 per cent. solution in an adult. In 1916, Ottenberg³ described a case of hæmophilia in which 6 gms. caused a marked drop in the coagulation time with a prolongation of the coagulation time 48 hours later. Kinsella and Brown⁴ in 1920, reported an attempt to control pulmonary hemorrhage during the course of influenza by the intravenous injection of sodium citrate in one gram doses and described the effect on the coagulation time in five patients.

By far, the most exhaustive and complete work on this subject up to date has been that of Neuhof and Hirschfeld.⁵ They report a series of 500 cases to whom sodium citrate has been administered, the last 200 being by the intramuscular route and conclude that such administration results in prompt

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and pronounced shortening of coagulation and bleeding time which is of two or three hours duration with a gradual return to normal within twenty-four to forty-eight hours. They established the optimum dose as 30 c.c. of a 30 per cent. solution, and the intramuscular route as the one of choice.

Our report is based upon clinical observations made in a series of over fifty cases to whom sodium citrate was administered intramuscularly. For several years the writers have independently used calcium lactate preparatory to operations, especially before tonsil operations. While no deleterious effects were observed, the clinical effects appear to be negative. With the advent of World War Veterans to the surgical service of the Soldiers Home in Milwaukee it has been the rule, particularly for ear, nose and throat patients, to admit them the day before the operation, the preparatory examination to include the determination of the patient's coagulation and bleeding time. The observations on the first patient of this series are typical.

Effects of the Administration of Sodium Citrate.—The coagulation time of this patient was eleven minutes on admission; ten minutes following the injection the coagulation time dropped to nine minutes; twenty minutes after injection the time was down to seven minutes; thirty minutes after injection the time was down to four minutes; forty-five minutes following injection, the lowest point was reached in this case, being two minutes. From then on there was a return to normal, but more gradual than the abrupt fall. One hour after injection the coagulation time in this case was three minutes; six hours after injection it was six minutes; twelve hours after injection it was seven minutes; eighteen hours after injection it was nine minutes; and until the coagulation time previous to the injection was reached. The field was drier following tonsillectomy in this case than the usual non-citrated case with normal coagulation time. This same patient was operated seven days later for deviated septum. His coagulation time then was nine minutes. The accompanying chart on the first twenty-five cases is of interest and speaks for itself. If necessary, the dose can be repeated in thirty-six hours, thereby controlling the coagulation time for a longer period. The majority of our cases were patients on whom nose and throat operations were performed and the results were highly gratifying. Any operator with much experience in tonsil surgery knows he must guard against hemorrhage. In all our cases of tonsillectomy previously citrated the field of operation was dry and remained so, and rarely sutures were necessary. In view of one septum patient who had some bleeding and the pleasing result of the other patients injected before operation, it is our opinion that sodium citrate is more effective when administered before the operation. If morphine or another narcotic is employed before operation the citrate can be conveniently injected at that time. That it is of some value when used during an operation is attested by its administration given during the course of a radical mastoid operation in a case of unusual, though not serious, oozing from the mastoid

bone. In this instance there was less sponging required than is usual when completing the operation some thirty minutes later in the attic and middle ear. In a case of common duct obstruction due to cholelithiasis, accompanied by intense jaundice, the coagulation time was reduced from nine to two minutes one hour after citrate injection, and no difficulty with bleeding was encountered during or after the operation. Sodium citrate was injected intramuscularly in three cases of pulmonary hemorrhage due to pulmonary tuberculosis, and while it cannot be conclusively stated that this was the sole factor in checking the hemorrhage; nevertheless it can be said that bleeding ceased twenty minutes following the injection. One case of intra-abdominal hemorrhage due to perforation of the cæcum was successfully controlled by this method. No untoward results, other than that of temporary local pain, have occurred in any of the injections.

Nature of the Reaction.—Baer and Rosenthal⁶ in a personal communication to Neuhof and Hirschfeld reported the results of their studies on citrated blood and concluded that the action of the sodium citrate was directly upon the blood platelets destroying them and liberating a substance which activates the process of coagulation. Drinker and Brittingham⁷ have demonstrated changes in the blood platelets accompanying early coagulation. Many of the platelets are partially or totally destroyed in transfusion of citrated blood. Hence in any disease such as hæmophilia, purpura hemorrhagica, pernicious anemia or Banti's disease where the pathology is a marked diminution or absence of blood platelets the injection of sodium citrate should not be used and in fact would tend to have a deleterious effect. This result is reported in Ottenberg's case of hæmophilia which gave a slight primary drop in the coagulation time, but soon showed a marked prolongation far beyond the original coagulation time.

Technic.—The solution used is sodium citrate C. P. 30 per cent. sterilized by boiling. The dose given is 30 c.c. and the site of injection is the buttocks. The skin over each buttock is cleansed with alcohol, dried, and tincture of iodine applied over a broad area. With a three inch needle, 3 c.c. of a 1 per cent. novocain solution is injected into each buttock. Three minutes are allowed to elapse, and then 15 c.c. of the citrate solution are injected into each buttock directly in the same area as in the injection of novocain. The novocain tends to diminish to a great degree the pain, and we find that gentle manual massage likewise alleviates the soreness which most of the patients complain of, but which is temporary only. Where time is an important factor, or where the condition of the patient is such that he cannot be moved, the entire 30 c.c. may be given in one buttock. This was done in the cases of the pulmonary † and intra-abdominal hemorrhages and mastoiditis with no untoward results. Tenderness was noticed in a few instances, but this was relieved even in the sitting position by a soft pillow or rubber

† Dr. Dunham of Oak Forest Sanatorium, Oak Forest, Illinois has successfully checked three cases of pulmonary hemorrhage by this method. Personal communication to the authors.

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ring. One case was followed by marked infiltration of one buttock which absorbed without fluctuation, with the aid of hot compresses; the pathology in our opinion being hæmatoma. Citrate was used by one of us in consultation in a severe case of post-operative hemorrhage in which horse serum and similar agents were administered before the citrate injection.

SUMMARY

1. The intramuscular injection of sodium citrate causes a prompt reduction of the coagulation time of a duration of one to three hours with a gradual return to normal with twenty-four to forty-eight hours.

2. This does not occur when the pathology is marked diminution or absence of blood platelets as in purpura, hæmophilia, etc.

3. A 30 per cent. C. P. sodium citrate solution is used, 15 c.c. in each buttock preceded by the injection of novocain. This method is apparently free from danger, no untoward results having been noted in over fifty cases.

4. The citrate cure occurs not only in persons who have an average coagulation time, but also in those having an abnormal prolongation, as in jaundice or from unknown causes.

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³ Ottenberg, R.: *Proc. Soc. Exp. Med. and Biol.*, 1916, vol. xiii, p. 104.

⁴ Kinsells, R., and Brown, G.: *J. A. M. A.*, 1920, vol. xxiv, p. 1070.

⁵ Neuhof, H., and Hirschfeld, Sam: *ANNALS OF SURGERY*, 1922, vol. lxxvi, p. 1.

⁶ Baer and Rosenthal: Quoted by Neuhof and Hirschfeld, *ibid.*

⁷ Drinker, C. K., and Brittingham, H. H.: *Transfusion Reactions*, *Arch. Int. Med.*, vol. xxiii, p. 133, Feb. 1919.

INTRACRANIAL ARTERIO-VEINOS ANEURISM OR PULSATING EXOPHTHALMOS

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(CONTINUED FROM P. 24)

CASE REPORTS COLLECTED BY THE AUTHOR

SPONTANEOUS TYPE

(1) BRUCE.—*Rev. Neur. and Psychiat.*, Edin., 1908, vol. vi, p. 462. F. 74, O.S. Spont. —sudden onset of pain all over head and subj. bruit—swelling of lids of both eyes—1 month later puls. exoph. O.S. with chemosis—fundus O.S. shows only congestion of veins—bruit systolic in time and widely transmitted—ext. ophthalmoplegia with ptosis—pupil somewhat dil. and reactionless—(V) impaired—abducens paresis O.D.—(T) conservative with rest, KI and sedatives—death—no autopsy.

(2) BOURGET and MIREAUX.—*Toulouse Méd.* 1909. vol. ix, p. 104. F. 28, O.S. Spont. Young woman with goitre noticed œdema of l. side of face and diminishment of (V) O.S.—puls. exoph. with subj. and obj. bruit—chemosis and dil. of veins of eyelids and conj.—fundus O.S. shows swollen veins—pupil dil. and reacts sluggishly to l.—no Wassermann nor X-ray (T) medication and digital compression for 5 days without result—lig. of carotid 3 months after onset produced considerable improvement.

(3) FRY.—*St. Barth. Hosp. Jour.*, 1910, vol. xviii, p. 40. F. 31, O.D. Spont. Suddenly while working had sharp pain of rt. temple—2 days later bruit and in 5 days diplopia and int. strabismus of O.D.—puls. exoph.—puls. swelling and thrill of brow—dil. veins of conj. and sclera—fundus O.D. and O.S. = veins full—(V) O.D. = 6/9; O.S. = 6/6—visual fields neg.—urine Sp. G. 1026, alb. neg.—compression of carotid stopped bruit—(T) digital compression will be used.

(4) ALBERTIN and DESGOUTTES.—*Recueil d'Ophth.*, 1910, vol. xxxii, p. 31. Sex ?, age ?, O.S. Spont. Sudden onset of puls. exoph.—in a few days amaurosis of O.S.—chemosis—lig. of left common carotid caused sl. hæmiparesis which cleared in 3½ days—puls. exoph. was cured but there was some loss of (V) from opacities.

(5) MORETON.—*St. Barth. Hosp. Rep.*, London, 1914, vol. xl, p. 73. F. 32, Side ?. Spont. onset with severe pain across temple and subj. bruit—typical puls. exoph. developed—no Wassermann nor X-ray—(T) systematic digital compression of carotid without avail.

(6) VAIL and OLIVER.—*Lancet Clinics*, Cincinnati, 1914, vol. cxii, p. 644. F. 72. O.S. Spont. (6 months previous to onset had rather insignificant trauma to l. frontal region)—onset at night—awakened by bruit and pain of O.S.—puls. exoph. with bruit best heard over O.S.—distinct pulsation near inner canthus—tenometer readings O.S. = 65 mm., O.D. = 20 mm.—complete ophthalmoplegia ext.—pupil dil. but reacts feebly to l. = V. O.S. = 20/50, O.D. = 20/20—visual fields neg.—fundus O.S. ? because of hazy media—O.D. shows pulsation of arteries and veins—B.P. 200/72—no Wassermann nor X-ray—compression of l. carotid shuts off bruit and pulsation (T) lig. of l. common carotid resulted in remarkable cure.

(7) SNOWBALL.—*Trans. Ophth. Soc., United Kingdom*, London, 1914-15, vol. xxxv, p. 169. M. 13, O.D. Spont. onset with intense headaches and vomiting—puls. exoph. with chemosis and widely transmitted bruit—dil. of vein about orbit with thrill—fundus O.D. shows retinal veins full and haziness of disc.—O.S. sl. swelling of upper inner

Abbreviations: M—Male; F—Female; arabic numerals indicate age of patient; V—Vision or Visual acuity; T—Treatment; Dil.—Dilated or Dilatation; Lig.—Ligation; Conj.—Conjunctivum; Sl.—Slight; Puls.—Pulsating or Pulsation; Obj.—Objective; Subj.—Subjective; Dim.—Diminished; O.D.—Right eye; O.S.—Left eye; Bilat.—Bilateral.

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margin of disc—movements of O.D. restricted—pupils equal not dil. but O.D. reacts only sl.—no Wassermann—X-ray neg.—pressure over carotid stops bruit—medication by mouth of no avail but no preliminary course of digital compression of carotid (T) lig. of rt. carotid and ext. jugular, facial and supraorbital veins improved puls. exoph. but death occurred in 9 days. Autopsy—arterio-venous communication between cavernous sinus and int. carotid.

(8) DAMSGAARD.—Ugeskrift f. læger, 1915, vol. lxxvii, p. 20. F. 78, Bilat. Spont. onset with violent pain of l. side of head especially in the temple with subj. and obj. bruit—in a few days exoph. appeared with proptosis and chemosis—23 days after onset pulsation of O.S. noticed—extraocular palsies which increased to complete ext. ophthalmoplegia—almost absent papillary reaction—no Wassermann, no X-ray—no history of lues—compression of l. carotid stops bruit—rt. does not—lig. of l. int. carotid without preliminary digital compression caused bruit to cease but hæmiplegia resulted, stupor and death 2 days later—no autopsy.

(9) KRAUSE.—Trans. Col. Phys., Philadelphia, 1915, 3. a., vol. xxxvii, p. 467. F. 57, Bilat. Spont. enormous bilat. exoph. O.D. more than O.S. which subsided for a time and then returned—continuous bruit accentuated in systole heard all over head, loudest over O.D.—pulsation of O.D. very marked—bilat. proptosis—complete paralysis of ocular muscles of O.D. with dil. and immobile pupil and complete blindness—fundi showed O.D. dil. veins, retinal hemorrhages with œdema of nerve and retina—later synechia and vitreous opacities O.S. vessels full, no neuritis—bruit ceases with compression of carotid—B.P. 202/125—Wassermann, blood and spinal fluid neg.—X-ray of skull neg.—visual fields concentrically retracted—T. of rest and digital compression caused sl. improvement, then recurrence—more digital compression effected some improvement O.S. becoming normal except for atrophy of disc and diminishment of V. to 5/18.

(10) TINDALL.—Hahnemann Monthly, Philadelphia, 1915, vol. 1, p. 671. F. 40, O.D. Spont. with onset of pain in globe and noise in rt. ear—puls. exoph. with bruit—congestion of conj. vessels—fundus O.D. showed questionable pallor of disc—diplopia and marked involvement of extraocular muscles—V. dim.—Wassermann negative—X-ray unsatisfactory—T. by pressure bandages to eye, mercury and iodides for 6 wks. followed by improvement in exoph. and ext. ocular palsies.

(11) RISLEY.—Trans. Col. Phys., Philadelphia, 1916, 3. s., vol. xxxviii, p. 343. Discussion of de Schweinitz and Holloway's paper.) Sex ?, age ?, side ?. Spont. puls. exoph. with bruit and proptosis—compression of carotid stopped bruit—T. by intermittent digital compression of carotid following which bruit, pulsation, and proptosis disappeared.

(12) MORAX and DUCAMP.—Ann. d'Ocul., Paris, 1916, vol. cliii, p. 252. F. 68, O.D. Spont. puls. exoph. with bruit over rt. temporal region accentuated during systole—fundus neg.—ptosis O.D.—diplopia—paresis of the extraocular muscles—pupil O.D. dil. and sluggish reaction—V. = 5/15—visual fields normal—no X-ray nor Wassermann—subcutaneous injection of gelatin without avail—lig. of rt. int. carotid without preliminary digital compression—6 days later l. hæmiplegia, exoph. and pulsation gone—death 36 days after operation. Autopsy—communication between int. carotid and cavernous sinus.

(13) FISHER.—Proc. Roy. Soc. Med., 1916, vol. ix, Part 3, Sec. of Ophth., p. 24. F. 59, O.D. Spont. onset with dizziness then fell unconscious—vomiting and pain in rt. frontal region—puls. exoph. O.D.—obj. bruit heard over eye and in fronto-temporal region—veins of upper lid distended—fundus O.S. showed veins fuller than O.D.—ophthalmoplegia ext. and fixed pupil—V. = 6/14 corrected—Wassermann neg.—X-ray neg.—T. -Kl administered by mouth, sl. improvement in sight and in eye movements.

(14) WATANABE.—Nippon Gank. Zasshi, July, 1916, p. 175. M. 19, side ?. Spont. puls. exoph.—good results followed lig. of the common carotid.

(15) RIMLEY (Discussion of Mayou's article, 1917, see below).—Sex ?, age ?, side ?. Spont. carotid without benefit—dil. of facial artery on same side—after lig. of facial artery puls. exoph. cured but blindness of l. eye.

(16) FRITSCH.—*Ztschr. f. Augenh.*, 1917, vol. xxxviii, p. 186. F. 60, O.S. Spont. Since childhood had prominence of and diminished V. in O.S.—noise in head, and headache—puls. exoph.—bruit subj. and obj. heard over O.S. and l. side of head—chemosis—fundus shows dil. veins and atrophy of disc—tension O.S. greater than O.D.—int. strabismus O.S. and reactionless pupil—no Wassermann nor X-ray—double lig. of l. common carotid followed by improvement.

(17) BOOT.—*Illinois Med. Jour.*, 1918, vol. xxxiv, p. 217. F. 21, O.D. Spont.—2 years ago noise in rt. ear and 9 months ago O.D. injected and swollen—now exoph. 3 mm., chemosis and bruit widely transmitted—large dil. veins of upper lid and inner angle of orbit with thrill—fundus O.D. marked fulness of veins—no mention of cranial nerve involvement—no Wassermann or X-ray—lig. of rt. carotid followed by complete cure.

(18) ZEEMAN.—*Ned. Tijdschr., von Geneesk.*, Amsterdam, 1918, vol. i, p. 778. F. 53, O.S. Spont. puls. exoph. $7\frac{1}{2}$ mm.—pupil O.S. dil. with no reaction to l.—fundus O.S. shows pale disc—absolute blindness O.S.—Wassermann positive—anti-luetic without results—lig. of ophthalmic artery and at which time a soft pulsating tumor of orbit was seen—sl. improvement, then recurrence and death. Autopsy, no details except multiple myelomata of orbit.

(19) TYSON.—*Arch. of Ophth.*, N. Y., 1919, vol. xlviii, p. 523. F. 43, O.S. Spont. with onset of severe pain behind O.S. and subj. bruit—puls. exoph. with obj. bruit and dil. of veins about eye—fundus shows oedema of nerve head and retinal hemorrhages—diplopia, pupil dil. with sluggish reactions and ext. ophthalmoplegia—7th nerve palsy—(V) O.D. = 20/30; O.S. = 20/50 corrected—X-ray neg.—Wassermann neg.—(T) by digital compression and iodides with resulting cure.

(20) LIEGARD.—*Ann. d'Ocul.*, Paris, 1919, vol. clvi, p. 621. F., age ?, bilat. Spont. onset with headache and vomiting—bruit in l. temporo-parietal region—bilat. exoph. without visible pulsation—paralysis of l. 3rd nerve—(T) by gelatin injections—end results were disappearance of exoph. and bruit but there was a 5th nerve palsy and loss of (V) of O.D.

(21) RUTIN.—*Wien. Med. Wchnschr.*, 1920, vol. lxx, p. 2027. F. 73, O.S. Spont. exoph. O.S. 4 mm.—systolic bruit loudest over l. temple—dil. of veins of inner canthus and episcleral veins—l. 6th and 7th nerve palsy—pupil dil. and reacts sluggishly—tension high—(V) O.D. = 6/6, O.S. = 6/12—Wassermann neg.—no X-ray—compression of l. carotid diminishes bruit—no (T) reported.

(22) SATTLER.—*Ztschr. f. Augenh.*, Berlin, 1920, vol. xliii, p. 534. F. 56, O.S. Spont.—after confinement 8 years ago developed intracranial bruit and headache—puls. exoph. 5 mm. with bruit accentuated in systole and heard best at inner canthus O.S.—swelling of upper lid—fundus O.S. sl. puls. of veins and paleness of disc—(V) O.S. = 5/30, O.D. = 5/5—sl. extraocular palsies—l. supraorbital nerve sensitive to pressure—Wassermann neg.—compression of carotid stops bruit—medication and digital compression resulted in improvement and later 6 subcut. gelatin injections gave further improvement.

(23) GOMES.—*Brazil Med.*, Rio de Janeiro, 1920, vol. xxxiv, p. 29. Sex ?, age ?, bilat. Spont. puls. exoph. of both sides—lig. of one common carotid without results and 3 months later expects to lig. the opposite common carotid.

(24) DEMARIA and JORGE.—*Rev. Assoc. Méd. Argent.*, 1921, vol. xxxiv, p. 29. F. 42, O.S. Spont.—Pt. arteriosclerotic with exoph. goitre—sudden onset with pain of O.S. and inc. of exoph. O.S. with puls.—loss of (V)—bruit—dil. of veins at inner angle of O.S. with thrill—dil. of conj. veins—sl. diminishment of ocular movements—tension 42 mm.—X-ray neg.—Wassermann neg.—later (V) gone—pupil fixed—compression of carotid diminished exoph. and bruit—gelatin injections, Hg. by mouth and digital compression used without avail—excision of dil. veins above eye—cure.

(25) BEHAN.—*N. Y. State Jour. Med.*, 1921, vol. xxi, p. 373. M. 27, O.S. Spont. onset purplish color of lower lid and $2\frac{1}{2}$ months later headache and bruit—puls. exoph.

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8 mm. with obj. bruit—conj. and scleral vessels distended—prominent int. angular vein with thrill—fundus O.S. shows engorgement of vessels, haziness of nasal margin of disc—visual field O.S. shows marked restriction both nasal and temporal—sl. extraocular muscle palsies—pupil O.S. greater than O.D.—(V) poor O.S. but had been for 2 years—no Wassermann—no X-ray—pressure of l. carotid obliterates bruit—(T) by carotid lig. without preliminary course of digital compression—cure of puls. exoph. and visual field enlarged—sudden death 4 months later—no autopsy.

(26) HALLETT.—*Am. Jour. Ophth.*, 1921, 3.S., vol. iv, p. 203. F. 74. O.S. Spont. puls. exoph. with subj. bruit, also obj. bruit, latter heard over orbit, l. frontal and temporal regions—proptosis—acute glaucoma chemosis, tension 68 mm.—dil. tortuous veins of upper lid and about orbit—complete ptosis O.S.—dil. reactionless pupil—ophthalmoscopic exam. showed central retinal atrophy from an old hemorrhage and vitreous opacities—no (V)—pressure over l. carotid or over angular vein caused bruit to subside—Pt. was suffering from nephritis—no Wassermann—no X-ray—lig. of l. common carotid and l. angular vein without preliminary treatment resulted in death—no autopsy.

(27) MÉRIGOT DE TREIGNY.—*Arch. d'Ophth.*, 1921, vol. xxxviii, p. 568. F., age ?, Side ?. Spont. subj. bruit—exoph. but puls. not visible—œdema of lids—bruit obj. with thrill—complete ptosis—intermittent digital compression of carotid without avail—lig. of common carotid and orbital veins followed by improvement.

(28) WHEELER.—*Arch. Ophth.*, 1922, vol. li, p. 401. F. 62. Bilat. Spont.—both moderate and excruciating pains of the l. side of head and subj. intracranial bruit—swelling and discoloration about orbit—bilat. puls. exoph. greater on l.—bruit heard all over head reduced by pressure over l. carotid—fundi neg.—B.P. 185/110—Wassermann neg.—X-ray suggested tumor?—lig. of l. carotid without preliminary (T)—hæmiplegia and death 39 hrs. later—no autopsy.

(29) BRYAN.—*Am. Jour. Ophth.*, 1922, vol. v, p. 808. M. 5, Bilat. Spont.—Puls. exoph. with bruit heard all over head—distended veins of temple and upper and lower lids—bilat. choked disc—(V) O.S. = 15/15, and O.D. = 15/15—no extraocular muscle palsies—visual fields normal—Wassermann neg.—X-ray neg.—bruit not abolished when both carotids were compressed—KI by mouth gave no results—later lig. of l. carotid did not cause improvement—still later lig. of l. superior ophthalmic vein was of no avail.

(30) RIEHM.—*Deut. Med. Wchnschr.*, 1922, vol. xlviii, p. 287. F. 43. Bilat.—Spont.—3 miscarriages but denies lues—in 1918, grippe and pain in O.S. and left ear—6 months later O.S. prominent and red, and pain commenced in O.D.—dil. puls. veins about eyes—then puls. exoph. of both eyes and bruit—fundi O.D. and O.S.—choked discs with hemorrhage of O.D.—rt. 6th nerve palsy—pupils react normally—(V) O.D. = 6/30; O.S. = 6/12—Wassermann neg.—X-ray showed thinning in region of sella—compression of both carotid arteries stopped bruit while compression of one only diminished bruit—no (T)—hernia operation, at which time Tb. lesions were found—death 12 days later. Autopsy—communication between int. carotid and cavernous sinus and Tb. peritonitis and salpingitis.

(31) DEMELLO.—*Arch. Brazil de Med.*, Rio de Janeiro, 1922, vol. xii, p. 143. F. 60, O.D., Spont. Ptosis of O.D. and immobile globe appeared 5 years ago after a fever at which time there was severe pain of rt. face and 5th nerve anesthesia—puls. exoph.—bruit of rt. temp. region—(V) O.D. = 1/10, O.S. = 1/4.

(32) GAZEPIS.—*Arch. f. Ophth.*, 1922, vol. cx, p. 375. Sex ?, age ?, O.S. Spont. with onset of 6th nerve paresis of O.S. and then exoph. without puls. but with bruit heard over temples—dil. of orbital blood-vessels and fundus O.S. showed dil. and tortuous veins—ocular tension 82 mm.—developed glaucoma of effected eye—general arteriosclerosis—lig. of left int. and ext. carotids without preliminary course of digital compression—exoph. relieved but hæmiplegia resulted and death in 3 days. Autopsy, aneurism of left carotid in cavernous sinus and softening of left cerebrum.

(33) CAUCHOIX.—*Bull. et Mem. de la Soc. de Chir.*, 1922, vol. xlviii, p. 20. F. 75, O.D. Spont.—awoke with violent pain and throbbing of head and heard bruit—exoph. with widely spread obj. bruit—chemosis—swelling of eyelid with thrill over it—somno-

lence—spinal puncture showed bloody fluid—Wassermann on fluid neg.—compression of carotid stopped bruit but caused syncope—attempted lig. of ophthalmic vein with so great hemorrhage that the operator found it necessary to lig. rt. common carotid—sl. paresis of left face after operation cleared quickly and eye signs disappeared—3 months later a left hæmiplegia.

(34) FISHER.—Proc. Roy. Soc. Med., vol. vi, Part 3, Sect. Ophth., May, 1923, p. 99. F. 54, O.S., Spont. After doing washing became dizzy and fell, striking the back of her head—on regaining consciousness heard bruit—next day ptosis of O.S.—8 days later 3rd nerve palsy and dil. pupil O.S.—puls. exoph. O.S. and loud systolic bruit heard over globe and left temporal and frontal region—fundus O.S. shows dil. veins—(V) O.S. = 6/18—X-ray neg.—no Wassermann—following lig. of common carotid pulsation and bruit disappeared—loss of vision O.S. to 6/24 and some limitation of movements of globe remained.

(35) WHITHAM.—Am. Jour. Ophth., 1923, vol. vi, p. 81. F. 26, O.S. Spont. appearing 10 days after parturition with subj. bruit and pain across forehead—œdema of lids and conj. of O.S.—puls. of globe but no definite exoph.—obj. bruit widely transmitted—fundus normal—complete ext. rectus paralysis O.S.—pupil normal (V) O.S. = 20/30 imperfectly—B.P. 140 systolic—Wassermann neg.—no X-ray—pressure over carotid stopped bruit—lig. of left int. carotid followed by cure.

(36) *Ibid.* F. 36, O.S., Spont. onset while recovering from miscarriage—ptosis and diplopia—int. convergence with left 6th nerve and partial left 3rd nerve palsy—1½ months later exoph. O.S. 7 mm. with loud and widely dispersed bruit—thrill—veins of lid O.S. dil. with marked œdema of bulbar conj.—fundus shows engorged veins without puls.—no Wassermann nor X-ray—pressure on carotid stops bruit—(T) by rest in bed with neg. results—died from influenza—no autopsy.

(37) *Ibid.*—M. 58, O.S. Spont. onset—exoph. 3–4 mm.—œdema of conj. with dil. veins—fundus shows deep physiological cup—V. = 20/30, partial ptosis—diplopia—paresis of ext. rectus O.S.—4 mos. later V. = 20/70, and complete 6th nerve paralysis and contraction of visual fields O.S.—4 mos. exoph. showed puls. for the first time—deafness left ear—obj. bruit—Wassermann neg.—X-ray neg.—pressure on left carotid stopped bruit—T. by iodides—condition unchanged.

(38) DAMEL and BARRIOS.—Rep. Ophth. Hosp., Buenos Aires, vol. i, p. 130. M. 61, Side ? Spont. onset with diplopia then facial paralysis and then puls. exoph.—loud intracranial bruit—no extraocular muscle palsies—V. good—compression of common carotid gave some relief of signs and symptoms.

TRAUMATIC TYPE

(1) CHEATHAM.—Louisville Monthly Jour. Med. and Surg., Jan., 1907, p. 267. M. 48, O.D. Fall followed by puls. exoph. with bruit over rt. temporal region—ptosis—fundus O.S. shows optic atrophy—(V) loss except for light perception—no Wassermann—no X-ray—lig. of rt. common carotid gave improvement for a time and then recurrence—neg. results.

(2) MENACHO.—(Discussion of Blanco's paper—see above). F. 57, Side ? Following trauma of the side of her head, pt. developed puls. exoph.—compressive dressing caused cure in 6 weeks.

(3) GIFFORD.—Ophthalmology, 1907, vol. iv, p. 21. M. 24, O.S. 6 months after head trauma developed puls. exoph. and 2 months later first noticed subj. bruit which could be best heard over O.S.—dil. of veins about eye—fundus normal—(V) O.S. = 20/50—lig. of ext. carotid gave neg. results—later lig. of common carotid and dil. of upper lid and still progression in signs—(V) diminished and puls. tumor with thrill and bruit appeared about eye—limitation of ocular movements—removal of mass relieved exoph.—improved ocular movements—(V) regained to 20/30—fundus showed sl. pale disc.

(4) DESCARPENTRIES.—Bull. de la Soc. de med. du Nord, 1908, Lille, 1909, pp. 501–503. De Raffele. M. 25, O.D., Trauma with loss of consciousness and ecchymosis about

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O.D.—6 months later consulted author because of prominence of O.D.—bruit subj. and obj.—swelling at inner canthus of eye and œdema—dil. of veins of conj.—no extraocular muscle palsies—fundus O.D. showed sl. œdema of disc—compression of swelling and inner canthus stops bruit—(V) O.D. = $\frac{1}{3}$ —no Wassermann—no X-ray—proposes (T) of KI, rest and gelatin injections.

(5) CARLOTTI.—*Am. Ocul.*, Paris, 1908, vol. cxxxix and cxi, p. 450. M. 35, O.D. Trauma of head with unconsciousness—rt. 8th nerve palsy, ecchymosis and ecchymosis of lids—puls. exoph. and ptosis of O.D.—intracranial bruit reinforced in systole—dil. veins of conj. and retina—pupils inactive and dil. and ext. ophthalmoplegia O.D.—(V) O.D. = $\frac{5}{10}$; O.S. = $\frac{5}{7.5}$ —visual fields normal—(T) rest gave no improvement—gelatin injections gave improvement.

(6) BECKER.—*Jahresbericht Gesell. Natur. u. Heilk.*, Dresden, 1908–1909, p. 1. M. 19, O.D. Revolver bullet entered rt. frontal region—2 days later exoph. and chemosis—amaurosis O.D.—pupil dil. and reactionless—enucleation 2 weeks after accident on mistaken diagnosis—2 months after operation author saw Pt. and found pulsation over rt. orbital fossa synchronous with radial pulse and bruit—no Wassermann—X-ray showed foreign body near sella—compression of rt. carotid shut off bruit.

(7) EVE.—*Proc. Roy. Soc. Med.*, London, 1909–1910, vol. iii, Clin. Sect. 77. M. 39, O.S. After trauma headache, swelling O.S.—puls. exoph. with systolic bruit over globe supraorbital and temporal regions—proptosis 8 mm.—enlargement of int. angular vein with thrill—fundus O.S. shows pulsation of dil. veins—diplopia—ophthalmoplegia in ext. O.S.—pupil reacts to light and darkness—good (V)—no Wassermann—X-ray shows fracture ?, left parietal region—(T) by rest and iodides—results not given.

(8) COTTERILL.—*Edin. Med. Jour.*, 1910, N.S., vol. v, p. 54. M. 31, O.D. Trauma—great pain and loud subj. bruit—5th day after accident ptosis—puls. exoph. with bruit heard all over rt. side of head—thrill over swelling about orbit—diplopia and rt. 6th nerve paralysis—fundus O.D. congested and haziness of both discs—(V) diminished O.D.—no X-ray—no Wassermann—compression of carotid stop pulsation—lig. of carotid followed by complete cure.

(9) FRY.—*St. Barth. Hosp. Jour.*, 1910, vol. xviii, p. 40. M. 38, O.S. Fracture of skull with unconsciousness—3 months later puls. exoph. and proptosis—bruit widely disseminated—dil. mass of vessels at inner brow with thrill—dil. and tortuous veins of lid—chemosis—fundus O.D. shows dil. veins. (V) O.D. = $\frac{6}{18}$; O.S. = $\frac{6}{5}$. Pupil O.D. larger than O.S.—T. by rest and KI with marked improvement in exoph. and bruit.

(10) BALBUENA.—*Arch. di. Oft. Hisp. Am.*, 1913, vol. xiii, p. 72. M. 25, C.S. Trauma. Shot in middle of forehead was followed by protrusion of O.S., puls. and proptosis—bruit loudest at upper inner angle of orbit—optic atrophy—T. by repeated gelatin injections subcutaneous and intravenous—cure of puls. exoph.

(11) MORETON.—*St. Barth. Rep. Lond.*, 1914, vol. xlix, p. 73. M. Age ?, O.D. Trauma of head followed by pulsating exophthalmos with bruit—treated by rest, KI and low diet—improvement.

(12) *Ibid.*—F. 55, O.D. Two weeks after head trauma subj. bruit, frontal headaches and œdema of lids—puls. exoph. with proptosis, chemosis and systolic bruit best heard above eye and in temporal region—dil. of veins above eye—fundus shows dil. veins—paralysis of ext. ocular muscles and pupil dil. with no reaction to l.—wound tension—V. O.D. = $\frac{6}{36}$ corrected to $\frac{6}{18}$, O.S. = $\frac{6}{6}$ —compression of carotid did not stop bruit. Systematic digital compression gave improvement and lig. of int. carotid removed puls. exoph. but pallor of disc and poor V. was the end result.

(13) SATTler.—*Lancet Clinic.* Cincinnati, 1914, vol. cix, p. 230. M. youth, Bilat. Blow on rt. side of head—unconscious—headache, vomiting and subj. bruit—exoph. O.D. with blurring of V.—one month later bilat. exoph. 2 cm. with puls. O.S. greater than O.D. proptosis and chemosis—bruit heard over O.S. and l. temple—fundus O.S. and O.D. showed dil. of veins and œdema of retina—marked dil. of epi bulbar veins—compression of l. carotid stops bruit and reduces exoph. T. not stated.

(14) TINDALL.—Hahemann Monthly, Phil., 1915. vol. 1, p 674. F. 55, Bilat. Trauma—bilat. puls. exoph. with bruit widely transmitted—dil. of veins of lids with puls.—fundus O.S. and O.D. showed engorgement of retinal veins with minute hemorrhages—not much visual disturbance—T. simply rest in bed and compress of eye—at end of 6 weeks much improved.

(15) RING.—Trans. Col. Physicians, Phil., 1916, vol. xxxviii, p. 338. F. 32, O.S. Trauma—History of congenital swelling at inner margin of l. orbit and following a second operation for this condition exoph. and proptosis of O.S. developed—with attack of influenza signs increased—puls. exoph. with bruit and chemosis and dil. of veins of lid and about eye, fundus O.S. showed areas of retina choroiditis—ocular movements sl. limited—V.—O.S. poor—T. not reported.

(16) RING.—Discussion of de Schweinitz case. Trans. Col. Phys., Phil., 1916, vol. lxxxvi, p. 343. Sex ?, Age ?, Side?. After trauma developed profound puls. exoph. and proptosis—2 months later lig. of common carotid was followed by almost complete recession of globe (improved).

(17) RHODES.—ANNALS OF SURGERY, 1916, vol. lxiii, p. 389. M. 27, O.S. Trauma resulted in severe headache and a subj. and obj. intracranial bruit and puls. exoph. 2 cm.—obj. bruit heard best over O.S. and l. temporal region—congestion of veins about eyes—pronounced chemosis—fundus O.S. shows marked venous stasis with enormous dil. and tortuosity and general œdema of retina—V.—O.S. blurred—no Wassermann nor X-ray—compression of l. carotid stops puls. and bruit.

(18) CAILLAUD.—Arch. d'opht. Paris, 1916-1917, vol. xxv, p. 746. M. 35, Bilat. Trauma followed in 19 days by puls. exoph. O.S. and then O.D.—bruit over O.S.—bilat. chemosis—dil. of veins above eyes with thrill O.S.—fundus showed dil. veins and arteries and pale discs—paresis of extraocular muscles more marked in O.S. than O.D.—corneal reflex about O.S. present O.D.—X-ray showed doubtful l. frontal fracture—no Wassermann—T. without avail by digital compression—lig. int. carotid both sides with 7-day interval—cure of bilat. puls. exoph.—hæmiplegia, aphasia and death 2 days post-op. Autopsy—no defect in cavernous sinus but int. carotid not examined.

(19) FRANKE.—Deutsche Med. Wehnschr. Leip. u. Berl., 1917, vol. xliii, p. 159. F. 40, O.D. Following trauma developed subj. bruit and puls. exoph.—obj. bruit also, systolic in time—paralysis of extraocular muscles, 3rd, 4th, and 6th nerves—pupil fixed—double lig. and removal of venous plexus behind eye—improved.

(20) SHAND.—Jour. Roy. Naval Med. Service, 1917, vol. cxi, p. 226. M. 34, O.D. Patient was struck on the head with wooden club—loss of consciousness for 20 min. with bleeding from nose and mouth—œdema about O.D.—10 days later pain and protrusion of O.D.—one month after accident bruit noticed and exoph. increased—fundus O.D. shows dil. retinal veins—unable to close lids O.D.—all movements of globe limited—blurring of vision—no Wassermann nor X-ray—compression of rt. carotid lessens bruit—lig. of rt. common carotid resulted in cure—sl. blurring of vision O.D.

(21) MAYOU.—Trans. Ophth. Soc. United Kingdom, 1917, vol. xxxvii, p. 186. M. age ?, O.D. Soldier received shrapnel wound behind rt. mastoid. X-ray located shrapnel in rt. temporal bone—puls. exoph. with bruit and proptosis—rt. facial palsy—lig. rt. int. carotid without avail.

(22) RIDLEY.—Discussion of Mayou's article (see above). Sex ?, Age ?, Side ?. Puls. exoph. with bruit developed after trauma of head—lig. of common carotid effected cure.

(23) WHITEHEAD.—Discussion of Mayou's article. Sex ?, Age ?, Side ?. Head trauma followed by puls. exoph. with intracranial bruit—lig. of common carotid effected cure.

(24) *Ibid.*—Sex ?, Age ?, Side ?. Puls. exoph. with intracranial bruit developed after head injury—lig. of common carotid was followed by cure.

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(25) GALORINE.—Brit. Jour. of Ophth., March, 1918, p. 174. (Abstract.) M. 18, Side ?. Trauma puls. exoph. T. by lig. of superior ophthalmic vein—puls. exoph. receded satisfactorily but there was loss of V. and optic atrophy.

(26) *Ibid.*—Sex ?, Age 58, Side ?. Trauma puls. exoph.—lig. of sup. ophthalmic vein gave good results as regards exoph. and puls.

(27) *Ibid.*—M. Age ?, O.D. Head trauma was followed in 1 hr. by subj. bruit referred to rt. ear—puls. exoph. proptosis—complete ptosis—some loss of V.—lig. of rt. carotid and sup. ophthalmic vein followed by satisfactory results and dim. V. returned somewhat.

(28) GIBSON.—Med. Jour., Australia, 1918, vol. xi, p. 203. F. 19, O.S. Head trauma followed by puls. exoph. with loud continuous bruit accentuated during systole over O.S. and over l. temporal region—fundus shows dil. of veins—proptosis—V.—O.S. and O.D. 5/6—pressure over l. carotid stops puls. and bruit—lig. l. common carotid followed by improvement.

(29) SALUS.—Klin. Monatsbl. f. Augenh., 1918, vol. lx, p. 253. M. 22, Bilat. Following accident bleeding and blindness of O.D.—bilat. puls. exoph. O.D.=25 mm., O.S.=24 mm., widely disseminated subj. and obj. bruit—many dil. tortuous vessels of conj.—nodulated puls. swelling at inner canthi of both eyes—fundus O.D. shows retinitis proliferous traumatica O.S. dil. and tortuous veins, puls. arteries and hyperæmic papilla—marked limitation of extraocular movements O.D. less marked O.S.—pupil O.D. rigid O.S. reacts well—loss of sensation of cornea O.D.—V.—O.D. amaurosis, O.S. dim.—visual fields normal—X-ray shows bone defect in ant. fossa—disappearance of bruit upon rt. carotid compression—no report concerning T.

(30) BELL.—Arch. Ophth. N. Y., 1919, vol. xlviii, p. 84. M. 48, Bilat. Trauma of head followed by puls. exoph. O.D.=24; O.S.=22—proptosis—bruit heard in both temporal regions more on rt.—fundus show engorgement of retinal vessels O.S. and O.D. and choroid retinitis O.D.—diplopia and restriction in ext. ocular movements—V. O.D.=20/50; O.S.=20/40. X-ray reveals no signs of fracture—no Wassermann—lig. of common carotid followed by decided improvement.

(31) MARGARUCCI.—Riforma. Med. Nap., 1919, vol. xxxv, p. 919. M. Age ?, O.S. Trauma followed by puls. exoph. with intracranial bruit—I year previous had lost opposite eye by war wound—dil. of vein about orbit and congestion of conj.—moderate chemosis—ptosis and deviation of O.S.—pupil reaction conserved—V. not impaired—Wassermann not taken—X-ray shows foreign body on rt. side in sphenoidal bone—compression of l. carotid does not stop bruit but pressure over rt. carotid does—conclusion was that arterio-venous communication was on l. side but failed to show because that eye had previously been enucleated—lig. of rt. common carotid was followed by some involuntary movements of l. side but no improvement of eye condition—following a second lig. of the same vessel the patient was cured.

(32) FASANO.—Discussion of Margarucci article. M. Age ?, Side ?. Fracture of the base of the petrous portion of the temporal bone a puls. exoph. resulted—no Wassermann—X-ray showed fracture—lig. of common carotid and jugular vein followed by death—fatality due not only to operation, but to severity of fractured skull. Autopsy—communication between cavernous sinus and int. carotid.

(33) MENACHO.—Arch. de Oft. Hisp. Am., 1919, vol. xx, p. 20. Sex ?, Age ?, O.D. Trauma of rt. side of head was followed by puls. exoph.—intermittent systolic bruit—puls. swelling of veins in rt. temporal region—V. O.S.=1/4, O.D.—blind—digital compression of artery was followed by disappearance of puls. and exoph. but atrophy of the optic nerve O.D. resulted.

(34) OURGAUD.—Marseille Med., 1919, vol. lvi, p. 607. M. Age ?, (soldier). O.S. Was knocked over by exploding shell and few days later developed exoph. which later pulsated—proptosis—bruit reinforced in systole was heard over eye—hyperæmia of conj.

—fundus O.S. reveals dil. vein with undulations synchronous with pulse—no Wassermann nor X-ray—no T. nor outcome reported.

(35) BIELSCHOWSKY.—Munchen Med. Wehnschr., 1919, vol. lxvi, p. 700. M. 13, O.D. Four weeks after injury developed diplopia and subj. intracranial bruit—puls. exoph. O.D. 13 mm. with obj. bruit particularly over globe—puls. greatly dil. veins near inner canthus and of supraorbital region also of upper lid—dil. veins of conj.—fundus O.D. shows dilated and tortuous veins—complete 6th nerve paralysis O.D.—V. and visual fields normal—no Wassermann nor X-ray—T. digital compression of rt. carotid for 8 weeks results not given.

(36) LAPERSONNE and SENDRAL.—Bull. Acad. de Med. Par., 1919, vol. lxxxii, p. 515. M. 37, O.D. Trauma followed by non-puls. exoph. with subj. and obj. bruit widely transmitted and synchronous with pulse but best heard in rt. temporal and frontal regions—retinal veins dil. congested and tortuous—chemosis—no Wassermann—no X-ray—pressure over carotid stops bruit—lig. of rt. common carotid without preliminary course of digital compression effected cure.

(37) *Ibid.*—M. 36, Bilat. Exophthalmos following trauma with subj. and obj. continuous bruit best heard in temporal region and accentuated in systole—chemosis dil. puls. angular vein with thrill—complete ext. ophthalmoplegia with complete ptosis—V. poor—fundi show œdema of discs—no Wassermann—no X-ray—lig. of rt. common carotid gave neg. results—after 5 months of digital compression, lig. of left common carotid caused marked improvement.

(38) MAGEE.—Am. Jour. Ophth., 1919, vol. ii, p. 74. M. 24, O.S. After trauma puls. exoph. developed with proptosis and subj. and obj. bruit over l. temple—veins of upper lid dil. and tortuous—congestion of bulbar and palpebral conj.—severe headaches—fundus O.S. neg.—ptosis and complete immobility of globe—pupil somewhat dil. and reactionless to l.—photophobia—V. O.S. = $\frac{1}{2}$ —enucleation followed by lig. of int. carotid without a preliminary course of digital compression resulted in hæmiplegia—in a few weeks hæmiplegia cleared and eye condition was practically cured.

(39) ARGANARAZ and DEL VALLE.—Rev. Asoc. Med. Argent., 1919, vol. xxx, p. 377. M. 27, Bilat. Severe trauma to head and bleeding from nose and ears 9 mos. ago—subj. bruit and later violent pain of O.S. Bilat. pul. exoph.—34 mm. with bruit—thrill over dil. vein—dilatation of conj. vein—fundi showed congested and swollen discs—pupils dilated and fixed—cannot converge with either eye—X-ray neg.—no Wassermann—compression of carotid dim. bruit—lig. of int. carotid caused hæmiparesis which recovered in 5 months—puls. exoph. much improved.

(40) *Ibid.*—M. 33, O.D. Head trauma in auto accident—bleeding, loss of consciousness—deafness rt. ear—pul. exoph. O.D. and bruit—fundus O.D. optic neuritis—paralysis ext. ocular muscles O.D.—V. dim to 2 meters—no Wassermann—no X-ray—T. by subcutaneous injections of gelatin—cure.

(41) SPENCER.—Proc. Roy. Soc. Med. Lond., 1919-1920, vol. xiii, clin. sect., p. 73. M. 26, Bilat. Traumatic pulsating exophthalmos with subj. and obj. bruit best heard over O.S.—proptosis greater O.S. than O.D.—venous engorgement both upper lids, more on left—chemosis O.S.—6th nerve palsy O.S.—carotid compression stopped bruit—no Wassermann—X-ray neg. Lig. of left then rt. common carotid followed by slight improvement.

(42) GOMEZ, No. 2.—Brazil Med. Ros de Jan., 1920, vol. xxxiv, p. 29. Sex ?, Age ?, Side?. After trauma of head developed a puls. exoph. with intracranial bruit—lig. of common carotid brought "satisfactory results."

(43) DE RAFFELE.—Riforma Med. Napoli, 1920, vol. xxxvi, p. 345. M. 20, Side ?. Puls. exoph. of traumatic origin. Treatment not stated.

(44) THOMPSON.—Am. Jour. Ophth., 1920, vol. iii, p. 605. F. 32, O.D. Following head trauma sharp pain around O.D., then marked exoph. and systolic bruit—chemosis—enlarged vessels of upper lid—fundus O.D. showed veins full and tortuous and disc

margins indistinct—ocular movements limited with complete absence of abduction—pupil sl. dil. and reacts to l.—V. O.D. = 20/70; O.S. = 20/30; no Wassermann—nor X-ray. Compression of rt. common carotid stopped bruit—T. rest and digital compression—results not given.

(45) ERGGELET.—Munich Med. Wchnschr., 1920, vol. lxvii, p. 412. M. Age ?, O.D. After trauma developed puls. exoph. with subj. and obj. bruit—extraocular palsies—pupil rigid—fundus O.D. showed only stubs of vessels—T. by lig. of int. carotid after lengthy preparation—improvement.

(46) POLLET and DECHERF.—Bull. et mem. Soc. de Chir. de Par., 1920, vol. xlvi, p. 102. M. 36, Bilat. Trauma of head with l. facial paralysis—15–20 days later continuous subj. bruit—puls. exoph. with chemosis of O.S. than of O.D.—obj. bruit over entire head—fundus showed dil. and tortuous veins—no X-ray—no Wassermann—compression of l. carotid stopped bruit—T. of digital compression failed—lig. of l. common carotid caused improvement.

(47) SATTLER.—Zeitschr. f. Augenh. Berl., 1920, vol. xliii, p. 534. M. 21, O.D. Fracture of skull followed by bruit in head and blindness O.D.—puls. exoph. 10 mm. with widely transmitted subj. and obj. intracranial bruit—puls. mass on upper lid and dil. of conj. vessels fundus O.D. showed puls. retinal veins—globe O.D. immobile—pupil moderately dil. and reactionless—tension O.D. 23–30 mm. O.S. 7–9 mm. V.—O.D. = 5/30; O.S. = 5/25—rest in bed and digital compression used without benefit—lig. of rt. int. carotid followed by improvement—3 months later developed rheumatism and died of pneumonia—no autopsy.

(48) *Ibid.*—M. 26, Bilat. Fractured skull followed by puls. exoph.—intracranial bruit and puls. swelling at inner angle of orbit—improvement with relapse in 1916—exoph. well marked again also puls. swelling near inner canthus—rt. pupil greater than l.—fundus O.D. showed dil. and tortuous veins—improved—2d relapse 1919, with exoph. of O.D. 19 mm. and now also of O.S. 18 mm.—puls. swelling enlarged—episcleral vessels dil. and tortuous and ciliary injection O.S. and O.S.—ext. rectus palsy O.D. pupil neg.—tension O.D. 15–11 mm., O.S. 14–15 mm.—fundus show dil. retinal veins and hemorrhages—medical T. and digital compression without avail—after lig. of rt. int. carotid pulsation returned in angular vein—and 3 days after lig. of angular vein bruit returned but became less marked, as did the other signs—improved.

(49) SATTLER.—M. 15, O.S. Fractured skull resulted in optic atrophy of O.S. and 4 months later exoph. then a puls. swelling at int. angle of orbit—17 years after accident, increase in exoph. and dim. motion of O.S.—then after one year of daily digital compression of carotid there was a sudden pain and signs of thrombosis of swelling at int. angle—following this marked improvement in signs—V.—O.D. = 5/5 corrected but disc of O.S. was atrophic.

(50) SATTLER.—Ztschr. f. Augenh. Berl., 1920, vol. xliii, p. 534. M. 17, O.D. One month after fractured skull bilat. 6th and 7th nerve palsies developed and 5 or 6 months later exoph. with blowing subj. bruit—proptosis 9 mm. forward 5 mm. downward—dil. veins with thrill in supraorbital region—fundus O.D. showed veins dil. and puls. and retinal hemorrhages—ocular tension O.D. 10–15 mm. O.S. 12–13 mm.—compression of carotid stopped bruit and puls.—course of digital compression for 5 days—lig. of int. carotid followed by improvement.

(51) SEYFORTH.—Munich Med. Wchnschr., 1920, vol. lxvii, p. 1092. M. 22, O.D. Trauma followed by puls. exoph., proptosis and chemosis—bruit synchronous with pulse—dil. and tortuous veins of upper lid and in supraorbital region with thrill—no Wassermann nor X-ray—compression of carotid causes thrill to vanish—lig. of rt. int. and ext. carotid without preliminary digital compression and mass lig. of veins of orbital ridge—sepsis developed and death 9th post-op. day. Autopsy—communication between aneurism of int. carotid with cavernous sinus and also with dil. ophthalmic vein.

(52) POSEY.—Penn. Med. Jour., 1920, vol. xxiii, p. 658. M. 66, Bilat. After head trauma developed bilat. puls. exoph. (O.S. 6 mm. and O.D. less)—proptosis and subj. and obj. bruit—mass of dil. veins with thrill above both eyes—both eyes practically immobile; pupils $2\frac{1}{2}$ mm. reacting sluggishly—fundi show marked dil. and tortuosity of veins and atrophy of both discs—compression of rt. carotid controlled bruit and puls.—partial occlusion by lig. of rt. carotid and lig. of prominent veins about eyes effected cure.

(53) *Ibid.* No. 2.—M. 50, O.S. Head trauma was followed by pain and swelling about O.S. and subj. bruit—puls. 6 mm.—dil. veins with thrill above eye—fundus shows dil. of veins and blurring of disc margins—only sl. ocular muscle palsy. V.—O.D. = $5/7.5$; O.S. = $5/21$; pressure over l. carotid stopped while pressure over rt. lessened bruit—no Wassermann and no X-ray—no preliminary course of digital compression of carotid. Hæmiplegia resulted after lig. of l. carotid and bruit stopped—death 2 weeks later—no autopsy.

(54) *Ibid.* No. 3.—F. 43. Bilat. Followed head trauma developed subj. bruit and diplopia—bilat. puls. exoph. O.D. 24 mm.; O.S. 22 mm.—bruit heard over both eyes—dil. blood-vessels in each supraorbital region—fundi show dil. and tortuous veins without neuritis—pupil O.D. 4 mm. with sluggish reaction while pupil O.S. $2\frac{1}{2}$ mm. and active—rt. 6th nerve palsy—V. each eye $5/9$. Pressure on l. carotid stopped bruit—lig. l. carotid and veins of rt. orbit and 10 days later resection of veins about O.S. resulted in improvement.

(55) FERRERO.—Arch. ital. di chir., Bologna, 1921, vol. iii, p. 405. F. 24, O.D. Fracture of skull in auto accident followed by pain in rt. temple and intermittent bruit in rt. ear—puls. exoph. O.D.—congestion about eye—diplopia—6th nerve palsy O.D.—no Wassermann—X-ray showed fracture of parietal and temporal bones probably extending into sella—lig. rt. int. carotid was followed by improvement.

(56) POULARD and BAILLIART.—Ann. d'Ocul. Par., 1921, vol. clviii, p. 227. Sex ?, Age ?, O.D. Trauma. After fracture of skull puls. exoph. appeared—both common carotids were lig. yet exoph. persisted and pupil remained dil. and immobile.

(57) YOAKAM.—Arch. Neur. and Psych., 1921, vol. v, pp. 754-755. M. 13, O.S. Gunshot wound. (See reference in present article, p. 16.)

(58) WEBER.—Abst. in Rev. Gen. d'Ophth., 1921, vol. xxxv, p. 140. M.—young man—O.S. Trauma. Bullet entered l. maxillary region and made its exit near rt. ear. Some weeks later a puls. exoph. developed. Lig. of common carotid resulted in improvement.

(59) UFFREDUZZI.—Giornale della R. acad. di Med. di Torino, 1921, vol. xxvii, p. 15. M. Age ?, Side?. Following temporo-parietal fracture developed puls. exoph.—lig. of int. carotid followed by cure.

(60) TEWFIK.—Bull. Ophthal. Soc. Egypt, Caro, 1921, p. 62. M. 15, O.D. Gunshot of head followed by puls. exoph. and proptosis—nodular swelling about eye with thrill—V.—O.D. = $6/18$ —no Wassermann—X-ray shows 2 small shot close to pituitary fossa—no T. nor results reported.

(61) MAY.—Jour. Iowa State Med. Soc., 1921, vol. xi, p. 346. M. 18, O.D. Fracture skull was followed by subj. bruit and puls. exoph.—obj. bruit heard best over globe—dil. veins at inner angle of orbit with thrill—engorged scleral veins—fundus O.D. shows dil. of vessels and obliteration of inf. retinal artery—bilat. int. squint—sl. dil. pupil which reacts to l & d—loss of sensation of cornea and about eye—V. corrected O.D. = $20/30$; O.S. = $20/20$ —no Wassermann—X-ray shows fracture of base involving sphenoid—lig. of sup. ophthalmic vein was followed by cure.

(62) RIESE.—Deutsche Med. Wchnschr. Leip. u. Berl., 1921, vol. xlvii, p. 1090. M. 17, O.S.—Headaches and intracranial bruit after trauma—puls. exoph. with obj. bruit over it—dil. of veins of conj.—extraocular palsies O.S.—pupil dil. and reactionless—optic atrophy and loss of V.—no Wassermann nor X-ray—T. by systematic digital compression of carotid—no improvement—lig. of l. int. carotid gave improvement—later enucleation of O.S.

(63) HARTSHORNE.—*Am. Jour. Ophth.*, 1921, 3. s., vol. iv, p. 353. F. 12, O.S. After head trauma marked exoph. (5 mm.) with obj. bruit over O.S. and l. temple—swelling about O.S.—fundus reveals dil. and tortuous veins—complete ptosis and paralysis of ext. ocular muscles O.S.—pupil dil. and inactive—V.=15/15—fields normal—no Wassermann—X-ray neg.—bruit stopped by pressure over l. carotid—lig. of l. int. carotid resulted in almost entire disappearance of exoph. and improvement in ocular paralysis.

(64) COTTLE.—*Am. Jour. Ophth.*, 1922, vol. v, p. 658. M. Age ?, O.S. Trauma—bullet penetrated cranial cavity entering left cheek—O.S. became swollen and V. was lost as well as all movements—puls. exoph.—proptosis—bruit widely transmitted—swelling in supraorbital region—conj. injected—corneal anaesthesia—hearing reduced on l.—X-ray shows bullet fragments in region of l. mastoid—lig. of l. common carotid very much dim. puls. exoph. and movements of globe returned—partial return of sensation to eye—some puls. of globe when patient is in prone position.

(65) KEY.—Discussion of Wheeler's paper (see above). M. 49, Side ?. After head trauma puls. exoph. with bruit, proptosis and dim. of V. to 20/200—T. by almost constant digital compression for 10 days and end of this time bruit disappeared, proptosis receded and V. improved to 20/25—cure.

(66) *Ibid.*—Sex ?, Age ?, Side?. Severe head trauma followed by puls. exoph. and bruit but disappeared with use of Neff clamp on common carotid.

(67, 68) KING.—Discussion of Wheeler's paper. Sex ?, Age ?, Side ?. Two cases of trauma—puls. exoph. treated by placing a silver band on the carotid arteries only partially obliterating the lumen—in 2 weeks after the first operation to the arteries will be completely obliterated.

(69) KUNZ.—*Zeit. fur Augenh.*, 1922, vol. xlvii, p. 166. M. 19, O.S. Trauma. Two months after head injury with symptoms of fractured skull pt. developed puls. exoph.—4 months after injury lig. of l. int. carotid caused symptoms to disappear—6 months later puls. exoph. returned.

(70) HEUSER.—Discussion of Kunz's paper (see above). Sex ?, Age ?, Side ?. Trauma following fracture of base of skull—puls. exoph. with bruit—T. not described.

(71) FENTON.—*Am. Jour. Ophth.*, 1922, vol. v, p. 802. F. 24, Bilat. Blow on jaw—unconsciousness—on awakening heard bruit in rt. ear—one week later diplopia and extraocular palsies—I month later puls. exoph. O.D. with obj. bruit—then paresis of 3rd, 4th and 5th nerves and corneal ulcer—5 months after injury bilat. puls. exoph. and paralysis of extraocular muscles on both sides—no Wassermann nor X-ray—lig. of rt. int. carotid (8 months) caused marked improvement.

(72) CAUCHOIX.—*Bull. et Mem. Soc. de Chir. de Par.*, 1921, vol. xlvii, p. 153, *loc. cit.*, 1922, vol. xlviii, p. 20. M. 47, O.D. Trauma—27 days later puls. exoph. O.D.—bruit accentuated in systole heard best over O.D.—dil. of veins about O.D.—no Wassermann—compression of rt. carotid stopped these signs—lig. of rt. and l. common carotid arteries, 3-day interval—improvement but recurrence in 8 months—lig. of rt. sup. ophthalmic V.—no report of result.

(73) SWIFT.—*Am. Jour. Ophth.*, 1921, 3. s., vol. iv, p. 124. M. 23, Bilat. Traumatic—bilat. puls. exoph. with subj. and obj. bruit heard in temporal and frontal regions—fundus show engorgement and tortuosity of arteries and veins and paleness of both discs—bilat. ptosis and both eyeballs fixed and sl. divergent—pupils dil. and reactionless and marked loss of V. in both eyes—no Wassermann nor X-ray—lig. of rt. int. carotid caused marked improvement of O.D. and sl. improvement O.S.

(74) PASCALE.—*Ann. ital. di chir. Nap.*, 1922, vol. i, p. 144. M. 20, O.S. Shot near l. ear—subj. bruit of l. side of head and l. facial paralysis—puls. exoph. with obj. bruit reinforced in systole—dil. of small arteries and veins of conj.—fundus O.S. sl. hyperaemia and dil. of veins—no Wassermann nor X-ray—V. O.D.=9/10; O.S.=1—urine normal—compression of carotid checks bruit—lig. of l. int. carotid effected complete cure.

(75) *Ibid.*—M. 17, O.S. After being kicked in region of O.S. by a mule the local condition subsided except for œdema of upper lid—subj. intraeranian bruit—auscultation revealed systolic bruit—puls. exoph.—tumefaction of upper eyelid with visible puls. and palpable thrill—no Wassermann—1 year later lig. of common carotid—death. Autopsy: Arterio-venous aneurism of int. carotid.

(76) WHITHAM.—Am. Jour. Ophth., 1923, vol. vi, p. 81. M. 30, O.S. Fracture of skull followed by rt. hæmiplegia and aphasia which soon cleared—marked puls. exoph. with subj. and obj. bruit—chemosis and great engorgement of palpebral and bulbar conj.—fundus O.S. shows retinal veins dark and dilated and disc margins blurred—lagophthalmos and definite restriction of movements of O.S.—normal pupil reactions—V. O.S. = 20/60; O.D. = 20/20 + + —Visual fields neg. Wassermann neg.—X-ray showed linear fracture of l. orbit—lig. l. int. carotid followed by great improvement.

(77) *Ibid.* No. 3.—M. 49, O.S. Six days after head trauma developed bilat, prominence of eye and congestion—l. subtemporal decompression was followed by aphasia and onset of puls. exoph. of O.S. with widely transmitted bruit—chemosis—dil. of retinal veins—cloudiness of media and cornea—6 weeks later lig. of l. int. carotid followed by complete cure.

(78) *Ibid.*, No. 4.—F. Age ?, O.S. One week after trauma developed puls. exoph. O.S. with loud bruit over globe and over l. side of head—œdema of bulbar conjunctivum fundus O.S. revealed full and tortuous veins and paleness of optic nerve—limitation of movements of globe—pupil neg. V. O.S. = 20/30; O.D. = 20/20—no Wassermann—X-ray neg.—lig. of l. int. carotid gave improvement.

(79) *Ibid.*, No. 5.—M. 45, O.S. Three weeks after head trauma diplopia, severe pain and puls. exoph. (3 mm.) of O.S. appeared—continuous intraeranian bruit accentuated in systole, also thrill—œdema of lids and of bulbar conj.—with dil. of vessels—all movements of eye absent—pupil reacts to 1 and d—V. O.D. = 20/30; O.S. = 6/200—5 days later lig. of l. ext. carotid and metal band placed on l. common carotid—patient discharged cured on 16th post-operative day.

(80) SANTA CECILIA.—Brazil Med. Rio de Jan., 1923, vol. xxxvii, p. 4. M. 19, O.D. Trauma followed by puls. exoph. synchronous with pulse with subj. and obj. bruit—conj. O.D. congested—fundus O.D. showed engorgement of veins—diplopia and rt. 6th nerve palsy—lig. of rt. common carotid without avail but later realization with lig. of ext. carotid gave marked improvement.

(81) Case report in present article, 1923.

(82) Case report in present article, 1923.

(83) Case report in present article, 1923.

CASES WITH ETIOLOGY NOT STATED

(1) COVER and STEVENS.—Ophth. Rec., 1909, vol. xviii, p. 128. Sex ?, Age ?, Etiol. ?. Puls. exoph. was cured by ligation of the common carotid.

(2) FULLER.—Discussion of Halstead's paper. Surg., Gyn. and Obs., 1911, vol. xii, p. 298. Sex ?, Age ?, Side ?, Type ?. Pulsating exophthalmos—ligation of common carotid with improvement and the recurrence—later pressure over orbit for long intervals effected cure.

(3) HEPBURN.—Am. Jour. Ophth., 1920, 3. s., vol. iii, p. 144.—M. Age ?, Side ?, Type ?. Pulsating exophthalmos with proptosis and bruit—dilated supraorbital veins—vision 6/6—ligature of common carotid did not improve the condition.

(4) ROBINEAU.—Gaz. des Hosp., 1921, vol. xciv, p. 187. Sex ?, Age ?, Side ?, Etiol. ?. Puls. exoph. in which ligation of one common carotid was made and then 5 or 6 weeks later the other common carotid was ligatured—the results were satisfactory.

(5) BURCI.—Discussion of Margarucci article (see above). M. Age ?, Side ?, Etiol. ?. Pulsating exophthalmos cured by ligation of internal carotid.

INTRACRANIAL ARTERIO-VENOUS ANEURISM

(6) KEY.—Discussion of Wheeler's paper (see above). Sex ?, Age ?, Side ?, Type ?. Case of pulsating exophthalmos with bruit—proptosis and some loss of vision—after ligation of the common carotid signs disappeared and vision improved (cure).

(7) MANN.—Discussion of Becker's case (see above). M. Age ?, Side ?, Etiol. ?. Pulsating exophthalmos with bruit was *cured* after an accidental severe head bumping.

(8) CLEGG.—Discussion of Mayou's article (see above). M. Age ?, Side ?, Type ?. Puls. exoph. without subjective bruit. Treated by ligation of carotid and patient when seen 1 year later was entirely cured.

(9) ELLIOT.—Discussion of Mayou's article. Sex ?, Age ?, Side ?, Type ?, Puls. exophthalmos with bruit heard all over head—patient improved without treatment.

(10) COLLINS.—Discussion of Mayou's article.—M. Age ?, Side ?, Etiol. ?. Pulsating exophthalmos with intracranial bruit—ligation of the common carotid was followed by disappearance of the pulsating exophthalmos and then some return later (improved).

BOOK REVIEWS

DISLOCATIONS AND JOINT-FRACTURES. By FREDERIC J. COTTON, M.D., Visiting Surgeon to the Boston City Hospital. Second Edition, Reset, 8vo, 745 pages with 1329 illustrations from drawings by the author. Philadelphia and London: W. B. Saunders Company, 1924.

Doctor Cotton first embodied his experiences and opinions in the matter of dislocations and joint-fractures in his book which was published fourteen years ago. That book was sufficient to establish his reputation as an accurate observer and an original thinker. Still more will this new edition add to his reputation. Much has happened since 1910. Experience has broadened—judgment has matured—surgery has developed, and it is well that the volume of so many years ago be now revised.

The special value for this book rests in its personal character. There is a certain dogmatism and positiveness about the way in which the writer's views are presented which is attractive and impressive. The field to which the author proposes to confine himself is the one in which most of the difficulties of traumatic bone surgery are found.

We recommend to the reader the careful perusal of the introduction which in itself, in the view which it gives of the problems connected with joint-fractures, is full of real surgical philosophy. We endorse especially this statement of his: "No damage to any machinery, human or other, increases its efficiency, and in the human machinery we cannot replace parts. Many breaks and dislocations do damage absolutely irreparable; many do damage entirely unrecognizable at the time. * * * Our duty is to obtain, in the given case, the best results obtainable in this case by whatever means are at hand. * * * No book can make a man a fracture expert. * * * Experience, common sense, capable and trained fingers, and perhaps most important of all what you call mechanical sense, must help him out."

The reviewer would like to emphasize this statement in fracture work. Common sense and mechanical sense are essential to make experience and technical training of especial value in fracture work. It is in the degree to which this book reflects these two elements, common sense and mechanical sense, that it is to be commended.

The wealth of illustrations which the book contains will increase its value to the student. The teachings are sound and clearly and forcibly presented. It is a welcome addition to the literature of joint and bone traumatism in which American surgery is already so rich. LEWIS S. PILCHER.

OPERATIVE SURGERY. By J. SHELTON HORSLEY, M.D., St. Louis. C. V. Mosby Company, 1921.

This single volume of 721 pages, containing 613 original illustrations devoted to operative surgery, is largely the result of the author's own personal experience. There is no attempt made to describe all surgical operations.

The ones that are described, however, have either been done by the author, himself, or are those, which, in his opinion, are best suited for the particular condition under discussion. The work while not complete is comprehensive. As a rule only one method is described. In several instances, however, several procedures are given. The sections on blood-vessel surgery, plastic surgery, gastro-intestinal surgery, genito-urinary surgery, and the chapters dealing with technic, drainage, infection, complications following operations, hemorrhage, shock and blood transfusion are especially illuminating and instructive.

The outstanding feature of the work seems to be the emphasis placed upon the importance of the physiologic function and the interpretation of the biologic processes that follow surgical operations. For instance, a cigarette drain placed into an abscess cavity does indeed accomplish drainage, but not mechanically. It drains because it is sufficiently irritating to produce a stimulus which reverses the flow of the local lymphatic circulation. The lymph instead of absorbing the pus pours out into and around the drain in an attempt to extrude it. Plating of fractures gives good primary results from a mechanical standpoint, but the biologic results are far from ideal.

The book under review is certainly not a text-book for the use of medical undergraduates. But, in the library of the younger doctor, who is studying to become a surgeon; to the surgeon who has already arrived; to anyone interested in the technic of operative surgery, this book will find a welcome place.

MERRILL N. FOOTE.

MODERN UROLOGY, in original contributions by American authors, edited by HUGH CABOT, M.D. 2 vols., 8vo, 2nd and revised edition. Lea and Febiger, Philadelphia, 1924.

This work is written by twenty-eight of the leading urological surgeons of the United States. It is by far the best book that has ever been written on the subject up to date. Most of the chapters are complete in every detail, giving full references to original sources, which is a most essential detail for a book of its sort.

Those articles which stand out particularly in vol. i, are as follows: IV.—Syphilis of Genito-urinary Organs. V.—Anatomy, Anomalies and Injuries of the Penis. VIII.—Infections of Urethra and Prostate. XIII.—Hydrocele, Hæmatocele, Spermatocoele and Varicocele. XVI.—Tumors of the Testicle. XVII, XVIII, XIX on the Prostate Gland.

The chapter on prostatic obstruction was written in the previous edition by the inimitable and beloved, the late Dr. Paul M. Pilcher, and will always stand as a monument to his genius and thoroughness. In the present edition this subject is ably handled in an unbiased manner, bringing the subject up to date.

If there are any weaknesses in this volume, they are in Chapter I, which is not complete in that it does not describe nearly all the valuable instruments of the day. Chapter III is so poorly illustrated that it is almost spoiled and Chapter VI is merely an exposition of the author's personal views, which does not seem to be sufficient for a book of this character.

BOOK REVIEWS

The outstanding thesis in the second volume is Chapter VIII.—Anatomy, abnormalities, injuries and diseases of the ureter. The author has presented the subject in a masterful manner. It is beautifully illustrated and should be a permanent monument to his scientific ability and personal pertinacity. The subjects particularly well handled are: Chapter II.—Malformations and diverticula of bladder; Chapter IV.—Infections of the bladder; Chapter V.—Stone in the bladder; Chapter VII.—Tumors of the bladder; Chapter XII.—Infections of the kidney. In fact, all the articles in the second volume are masterpieces with the possible exception of those dealing with parasites of the bladder, which present a very difficult subject and concerning which nothing particularly new has been contributed of late years.

In reviewing a work of such excellence, one hesitates to make any criticism of an adverse nature whatever. There are one or two points which, if corrected, might strengthen the work as a whole.

It is unfortunate that space prevented the publication of the historical review of Genito-urinary Surgery in America, as this is always a most interesting feature of any book.

Blood chemistry is very lightly handled for such an important subject and the question of local and regional anæsthesia, which has assumed so much importance of late, is merely mentioned.

These two volumes must necessarily be used by the special student in urology and not by the general student in medicine and surgery, therefore the author who completed his thesis without giving full and complete references to all of his original sources of information has not presented a finished product for this type of publication. When one observes the large number of authors involved, he notices that the list of incomplete chapters is happily very small.

OSWALD S. LOWSLEY.

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A BIPOLAR THEORY OF THE NATURE OF CANCER

PRESIDENTIAL ADDRESS, AMERICAN SURGICAL ASSOCIATION, APRIL 17, 1924

BY GEORGE W. CRILE, M.D.

OF CLEVELAND, OHIO

THE history of medicine has shown that the field of cancer has been a hospitable cemetery for the hopes of the sponsors of many theories and the problem presented by man's grimmest enemy is still a mystery. It is not necessary to enumerate before this group any statistics to remind us of our obligation to prosecute the study of cancer by every method of investigation at our command. For these reasons, therefore, I have decided to offer a discussion of a theory as to the nature of cancer which is suggested by a new line of investigation. It is not expected that this theory will escape the common lot of cancer theories, but whatever happens to the theory certain facts will probably survive.

Cancer originates and lives only in the living—never in the non-living. It follows that our problem is concerned with the struggle for survival between the cancer cell and the normal cell; and the logical point of attack therefore is the nature and structure of the normal cell as compared with the nature and structure of the cancer cell. It is proposed, on this occasion, to search the normal and cancer cells for such physical differences as may explain the superior ability of the cancer cell to multiply at the expense of other tissues in which it grows.

The best known example of growth energy is that initiated by fertilization in reproduction. The outstanding facts regarding fertilization which may throw light on the cancer problem are the following:

1. The spermatozoon has the properties of the nucleus of the ovum with which it unites.

2. The spermatozoon may be said to reinforce the nucleus and as a consequence,

3. The quiescent negative ovum flares up in active metabolism and growth and in consequence shows a striking change in its internal structure and assumes electrical properties; *i.e.*, electricity is a constant phenomenon from the moment of fertilization, so long as the life of the new individual lasts.

This comparison of the processes of the multiplication of cancer cells with

that of fertilized cells is no new conception, the similarity of the nuclear changes having even led to the supposition by some that malignant processes actually were the result of some form of fertilization. Moreover the cyclic variations in the growth of tumors correspond to the cyclic changes in nuclear and mitotic activities which have been observed in protozoons.

The whole histologic picture of malignancy indicates that it is primarily nuclear in origin as is suggested especially by the large nucleus plasma ratio which is maintained either by the size of a single nucleus or by multiple nuclei; by nuclear hyperchromatism in the active stages; and by the shrinkage of the nuclei in the degenerating or necrosed areas.

On the basis that the processes of cell division in cancer are analogous to the processes of cell division in fertilized cells, we shall report certain biophysical researches and point out certain pertinent facts tending to show that cancer falls within the domain of the electro-chemical or bipolar theory which we believe applies to normal living processes.

Certain analogies between cancer and the pyogenic infections may aid in this interpretation. Cancer cells multiply, bacteria multiply, each finds restraint in certain tissue. Neither cancer nor the pyogenic infections commonly attack tissues of high oxidative capacity; thus neither cancer nor pyogenic infections primarily attack the heart muscle, the voluntary muscles, the cortex of the brain, the normal thyroid gland, the liver, the parenchyma of the kidney, the spleen, etc. No enzyme, no specific chemical property has been found to account for this fact. These are tissues of high chemical activities; these organs are homogeneous in structure and their unit cells are closely approximated and bathed in fluid; in other words, these organs are concentrated cell suspensions. Neither infection nor cancer attack successfully the anatomically and physiologically intact surface layers of cells like the skin and mucous membranes, the latter in turn being electrically charged cell suspension systems; they attack rather the less cellular structures which normally are protected by cellular layers.

Our first generalization then is that cancer originates not in the *midst* of a cell suspension such as the cellular organs, but at the boundary points between highly cellular and less cellular structures. These less cellular structures—subcutaneous, submucous—are successfully attacked by cancer or infection only when the cellular defense is broken down; in the case of a pyogenic invasion a single break in the line of defense may be sufficient for entrance; cancer depends rather upon the gradual lessening of the defense which results from the frequent breaking down and building up. Once the rapid infection or the slower cancer has passed this first line of defense, each follows the path of least resistance—namely, the lymphatic channels and the connective tissue, rather than attacking the solid cellular organs.

Another analogy between cancer and infection is found in the fact that

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each obeys laws of cell division and growth which apparently are the same as those which govern the cells of the host.

Both cancer and infection are repulsed by vigorous metabolic activity within the defending structures; thus, as we have already noted, the heart muscle, the voluntary muscles, the normal thyroid, are relatively immune. To this fact, we may add the significant fact that bacteria do not attack the most active part of the cell itself; that is, the nucleus of the cell is immune to pyogenic invasion. To this statement it should be added that the cell nucleus and bacteria show a similar stain reaction. Finally, unlike the normal cells of animals, cancer cells and bacteria have no specific function; they possess only growth energy.

A consideration of these facts suggests the following biophysical interpretation based upon the argument which was presented in the Murphy oration as published in the April, 1924, issue of *Surgery, Gynecology and Obstetrics*. The conclusions drawn from that argument are (1) that the difference between the living and the non-living films which surround the nucleus and the energy on the dielectric lipid films depends upon the accumulation of free cytoplasm and the numerous spherules within the cells; (2) that the charges on these films are derived from oxidation; (3) that oxidation within the cells is governed by the difference in energy potential between the nucleus and the cytoplasm; and (4) that therefore both the growth and the special function of cells are dependent on their structure and their energy potential. Thus the area of oxidating surface in the nucleus of a cell as compared with the area of oxidating surface in the cytoplasm is another way of expressing the nucleus plasma relationship and signifies that the larger the nucleus in comparison with the cytoplasm the greater the energy potential of the cell. Thus, if two cells have an identical organization, an identical energy potential, then, with respect to each other in the competition for nutrition their chances are even, but if in one of two adjacent cells the size and organization of the nucleus is such as to give it a greater capacity for oxidation, hence a greater demand for nutrition, then the cell of comparatively low oxidative capacity will suffer in the competition and will break down in starvation.

As we have stated above, in cancer cells the nucleus plasma relation resembles that of fertilized cells. Before fertilization the ovum in itself is so lacking in organization and hence in oxidative capacity that there is apparently little or no difference in potential between its nucleus and its cytoplasm—it carries no electric charge, it is inactive, negative. But when the nucleus of the ovum is reinforced by the nucleus-like spermatozoon there is at once established a difference in energy potential within the cell, oxidation becomes rapid, nutrition is demanded, the size of nucleus increases, mitosis is inaugurated, cell division occurs.

As we have stated, our interpretation of cancer assumes that the difference between the cancer cell and the neighboring cells of lower potential is analogous to the difference between the unfertilized and the fertilized ovum. The

analogy ends, however, once the mechanism of cell division has been established, for cancer cells have little or no differentiation.

If the foregoing biophysical interpretation be correct, then cancer tissue must meet the following biophysical requirements: (1) the cancer cells must have a high capacity for the storage of electric charges and (2) the conductivity of cancer tissue must show specific variations from the conductivity of normal tissues. That is, if our assumption is correct, then the lipid films of cancer cells of normal cells and of fertilized cells would take electric charges in a direct ratio to the combined surface area of their lipid films. For instance, though in its external appearance a fertilized fish egg is apparently the same as an unfertilized egg, one would expect the former to show a higher capacity than the latter; one would expect that the capacity of cancer cells would be higher than that of normal cells. One would expect that radiation would lower the capacity of cells. One would expect to find a higher capacity in such cellular tissues as the brain, liver, muscles, adrenals, thyroid, spleen, pancreas, than in such indifferent tissues as connective tissue and fat.

Our first researches along biophysical lines were a series of conductivity measurements of normal and of pathological tissues made in collaboration with Helen Hosmer, B.S., and Amy Rowland, M.A. The clinical tissues measured included malignant and benign tumors of the breast and of the uterus, ulcer and carcinoma of the stomach, carcinoma of the rectum, malignant and benign tumors of the mouth, jaws, and neck, X-ray burns and various types of goitres—hyperplasia, fetal adenoma, multiple adenoma, toxic adenoma, exophthalmic goitre, simple colloid goitre, thyroiditis. The following were the significant findings:

1. In all instances in which comparative measurements were made the conductivity of the malignant growth was higher than that of a normal portion of the same organ.

2. The outer growing parts of cancers showed a high conductivity in contrast with the conductivity of the central non-growing parts.

3. Among the goitres studied the highest conductivities were found in the degenerating adenomata and the malignant thyroids; the conductivities of the hyperplastic thyroids were lower; and the conductivities of the colloid goitres were the lowest of any of the pathological tissues studied.

These measurements were made with an alternating current of 1000 cycles. This comparatively low frequency of current would probably find the path of lowest resistance, in large part, undoubtedly through the inter-cellular tissues.

Extending this line of inquiry, the theoretical requirement that cancer tissue must have a high capacity for the storage of electric charges, was given to Hugo Fricke, Ph.D., and Sterne Morse, M.D., of the Biophysical Department of the Cleveland Clinic Foundation, for investigation. The versatile mathematical mind of Doctor Fricke has derived a formula and devised an

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apparatus whereby frequencies ranging from 100 to 1,000,000 or more cycles can be applied to the cells under investigation. Up to the present time currents varying from 3000 to 125,000 cycles have been used. The physical estimations of the capacity of normal tissue and of benign and malignant tumors thus far made are as follows:

Eighty tissues from 58 cases have been investigated, including 15 carcinomata of various types, 3 sarcomata, 3 benign tumors and 16 goitres of various types. The capacity of normal tissues have ranged from 0.47 for fatty tissue, and 1 to 3 for connective tissue to 10 for the normal uterus. All of the carcinomata have had a relatively high capacity ranging in the arbitrary units used from 11 to 32 in the actively growing portions of the growths. The degenerated portions of the growths have had a lower capacity and the capacity of radiated tissues has been much lower, the tissue in one radiated case showing as low a capacity as three. Thus far in every case studied the cancer itself. This difference has been particularly marked in carcinomata of the breast in which the capacity of the adjacent glandular connective or fatty tissue has often been less than one-tenth that of the malignant tissue. Among the goitres, colloid goitres have shown the highest capacity of any tissues studied, as much as 76 in one case, the average being in the neighborhood of 40. This finding is of prime significance in view of the fact that cancer of the thyroid never develops in a colloid goitre. Adenomas and hyperplastic thyroids have, as a rule, had a low capacity for glandular tissue which in general seemed to show a somewhat higher capacity than other tissue. Connective tissue has usually a very low value, between one and three, and the capacity of fatty tissue may be as low as 0.47, while an active inflammatory process may show a capacity of 20.

The findings in these researches suggested at once that the whole story of cancer may ultimately be derived from conductivity and capacity measurements. These findings moreover are in accord with the histologic picture presented by the microscope. The microscope indicates the general structure, which in turn *indicates* the capacity of the cell for work, multiplication, function, etc. A further striking parallel between the cytologic picture and biophysical findings, is found in the fact that Ewing and Wood have shown that cells which have been subjected to lethal X-ray or radium radiation, show loss of differential stainability and in our laboratory Morse has shown that heavily radiated tissue almost wholly loses its capacity.

Armed with these physical facts, let us see to what extent some of the well-known facts regarding cancer may be harmonized. First of all, on the basis of electric potential, implying as it does oxidative capacity, if two cells are side by side competing for food, the one having the higher potential, such as the fertilized cell or the cancer cell starves out, and if the higher potential—higher oxidative capacity—persists long enough, destroys the ordinary tissue. Among cells with equal capacity such as those within the cancer :

daughter cells of the fertilized ovum, division occurs evenly, no one starves another. This fact explains why cancer does not arise either primarily or secondarily in that fiery furnace, the heart muscle, or in other muscles, or in the cortex of the brain or in the thyroid gland, etc. It also indicates why, when from some cause, the capacity of an epithelial cell resting on subcutaneous or submucous cells of low capacity has been increased until it is equal to the capacity resulting from fertilization, that cell will easily rob the neighboring inactive tissues of their nutrition and will supplant them, just as the vigorous growing weed overgrows and supplants the highly differentiated less vigorous domestic crops.

A consideration of the conditions under which cancer develops in the thyroid gland is illuminating. First, cancer almost never develops in the normal thyroid or in colloid goitres, but over 90 per cent. of cancers of the thyroid arise in fetal adenomata. Now, as has been stated above, the capacity measurements made by Morse show that both colloid goitre and the normal gland have a higher capacity than cancer of the thyroid while the capacity of fetal adenoma is lower than that of cancer. Now on the basis of our premise one would have predicted that that would be the case, even though he knew nothing about the actual incidence of cancer in the thyroid gland.

Again, let us consider one of the most common sites of cancer origin, the breast. Here is an organ whose structure contains epithelial cells, the capacity of which is low. It follows that when some circumstances bring cells with a relatively high potential into contact with these low capacity epithelial cells, the former multiply at the expense of the other breast tissue. The capacity of cancer of the breast is from two to ten times higher than the capacity of normal breast tissue. The capacity of the tissue near the cancer mass is somewhat higher than that of normal tissue. In general, benign tumors have a higher capacity than that of the organ in which they grow, *e.g.*, the capacity of a fibroid is higher than that of the normal uterus.

There is a general analogy to this conception of the law governing the incidence of cancer in the various tissues, in the tables of Voit, which show that in starvation the weight of the brain and of the heart muscle does not change, the reason being that these tissues, the metabolism of which is at a higher rate than that of other tissues, consume the nutrition at the expense of the others. For the same reason a foetus thrives up to the point of starvation of the mother.

This conception explains the higher incidence of cancer in old age when the generally falling metabolism would diminish the already low defense of the tissues of low capacity and lead to an inequality in an already wavering balance between the capacities of neighboring cells. Moreover the older and the feebler the subject, the slower the growth of cancer and the better the prognosis; and *per contra* the younger and more vigorous the subject, the shorter the course, the more fatal the cancer. But youth has fewer cancers

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than old age. Our theory interprets this antithesis as follows: In the general activity of all tissues in youth it would be unusual to find the potential of any one cell raised above that of its equally vigorous neighbors, but once so phenomenal a cell has been produced, its growth energy would be enormous, rapid and fatal. In old age, on the other hand, with its universal decline in activity, although a cell may more readily become endowed with the equivalent of fertilization so that its potential and its capacity may become higher than those of its feeble neighbors, yet it would have a very moderate growth energy. In fact, cancer in the aged and feeble inevitably would appear just above the low level of low vitality, in youth just above the high level of general vitality. In youth the cancer must be virile; in age it must be feebler. Thus, in experimental studies cancers are not transplanted to the muscles, nor to the liver, nor to the heart, nor to the brain, but to the more negative tissues; it is the subcutaneous quiescent breast tissue that is generally selected as the site for the graft.

If one could plant a self-limited bacterium in the nucleus of a cell, its added oxidation might augment the nucleus in a manner analogous to the augmentation of the nucleus of the ovum by the spermatozoon so that in consequence cell division would be forced. Or if one could draw the nucleus out of one cell and insert it into a sister cell, thus reinforcing its nucleus, the energy potential of the latter cell would be increased, its nutrition intake increased and cell division would follow, *i.e.*, a cancer would be produced.

The interpretation of another fact is made possible by the bipolar theory, namely, the like action of X-ray and radium on cancer and on fertilization. The effect of radiation is to interfere with the mechanism in the cell for the creation and storage of electric charges, an interference which as effectively prevents growth and function as does the permanent injury to the plates of a battery.

Certain everyday facts about treatment are also open to a biophysical interpretation. Thus if a cancer is entirely removed, early, no return is seen, whereas if these electro-chemical mechanisms are stimulated by injury, by partial operation, by inflammation, by chemical agents, by X-ray, by radium, by heat, by electricity, the resultant struggle and survival kill off the weaker cells, leaving the stronger. When a massive treatment is given any cells which survive will be the fittest, hence the return growth will be at the pace of the strongest, the fittest cancer cells, not of the less strong cells that did not survive. The combination of diminishing vigor, on the one hand, and a stepping up on the other, theoretically would bring about the unbalance required for cancer.

Pyogenic Infection.—We have already mentioned certain analogies between cancer and pyogenic infections. Certain further biologic principles governing infection which appear to be the same as those governing cancer may be cited. The resemblance between cancer and infection has been noted by many observers. Pyogenic bacteria may be regarded as free nuclei, like

the fragmented nuclei seen in many unicellular organisms. If we regard the law of universal bipolarism as a necessary condition by means of which a difference in potential is created and oxidation controlled with resultant electric charges and maintenance of potential, we may interpret bacteria as free nuclei depending for their common negative pole on the common colloids such as mud, soil, seawater, etc., or the colloids in the tissues and fluids of animals. Bacteria then will multiply as free nuclei.

A cancer cell is a bipolar mechanism within which the nucleus is the positive, the cytoplasm the negative pole; bacteria are positive poles with lymph and tissue juices as a common negative pole. According to this conception the cancer cell and the bacterium are in a common class of high potential invaders. Now the bacterium like the cancer cell must depend on its ability to compete with the cells of the organism for nutrition. It is probably a consequence of this fact that bacteria, like cancer, cannot primarily compete with the cells of the organs which have a high metabolism. Bacteria like cancer attack best the negative tissues, the subcutaneous tendons, the fascia, the bone, surfaces that have been irritated. Bacteria stain like nuclei; bacteria almost never attack nuclei of cells, almost never muscles, most seldom of all the heart muscle. Bacteria tend to spread by the adynamic lymphatic system rather than by the dynamic blood stream. However, as in the cancer, if bacteria are potent enough, *i.e.*, have the required potential to multiply in the blood stream those bacteria are more apt to kill and to kill early. We find then that both bacteria and cancer cells multiply at the expense of their host; both may form tumors; both cause reactions; both interfere with function; both are selective as to the attacked organs, as to invasion. Though they have much in common, they are nevertheless entirely different.

As to the problems suggested by this discussion it would seem that in the capacity estimations we may have one more criterion for the diagnosis of cancer. Should this hope be realized, the estimation of capacity will best be made on fresh unstained tissue almost instantly after its removal or when conditions permit, *in situ*. Even if this should not become a specific method of operating room diagnosis, it will quite surely, even in its present status, supplement the microscope. We may perhaps find in this new biophysical method not only a means of diagnosis, but one of prognosis as well—a low ratio of the capacity of the growth to that of the adjacent tissues would theoretically mean low malignancy and vice versa. There is one more and a unique possibility, namely, that after the effects of radiation on capacity have been studied further it may be that the capacity of a tumor may at last furnish the key to the amount of radiation required as a lethal dose; or indeed it may determine whether any dose that the normal tissue of the organism could endure would cure, so that futile efforts could be avoided. There are still other interesting lines of investigation but a discussion of these is reserved for a further report by Doctor Fricke and Doctor Morse.

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In conclusion one of the greatest obligations science owes to humanity is the control of cancer, and it is hoped that the suggested theory, on the one hand, and on the other hand the new facts which have been and are being demonstrated by the more exact sciences of mathematics and physics, may contribute a new method of attack. The theory has at least this advantage, that it has been formulated and developed on the basis of exact mathematical formulæ and physical laws and in consequence can the more readily be disproved if not true, and if true can be the more easily defended.

THE FULL THICKNESS SKIN GRAFT*

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THERE seems to be little question that the Ancient Hindus made free transplants of the full thickness of skin and included some of the underlying tissue, but their percentage of successes may not have been very high. The

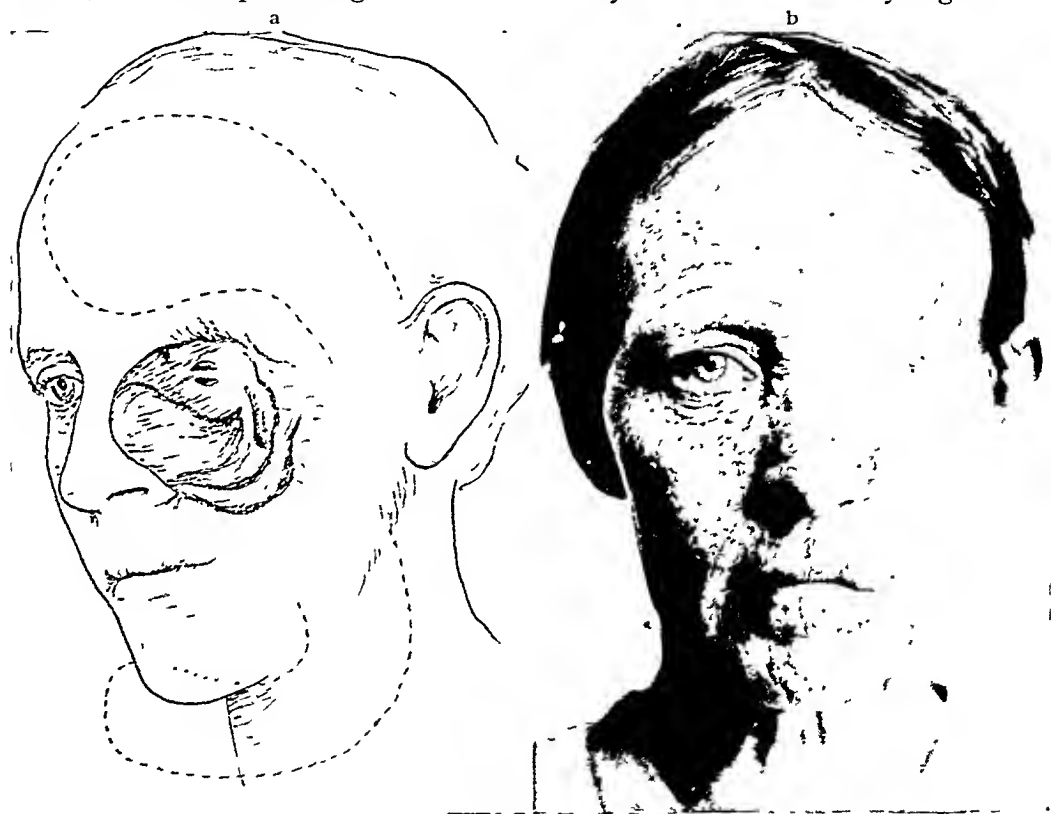


FIG. 1.—Shows a full thickness graft on the forehead used to replace a flap that covered the cheek or orbit defect. On the third day after operation, because the graft was found to be dusky, the epidermis was incised to relieve the congestion and this produced a very free flow of bright red blood.

accepted technics and standards of to-day are not based on the Hindu method, but are rather an evolution, an early stage of which was recorded by J. Mason Warren in 1843. Its later developments have been chronicled by various surgeons down to and including J. Staige Davis, who has made valuable contributions to the technic and has given us one of the most comprehensive reviews and bibliographs on this subject. Another and more recent review is by Neuhof. From these latter we learn that the contributions of both Wolfe and Krause appeared chronologically rather late in this evolution.

In spite of all that has preceded, it still remains a surgical resource of which the profession at large is not making full use. The following account

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of our experience with this method of covering external surface defects is presented not as something new, but on the possibility that it may help to stimulate more interest in the procedure which in turn may hasten the elimination of certain malign influences that still cause our own results to fall far short of 100 per cent. perfect.

Excluding army and Veterans' Hospital cases, it is based upon 106 autografts done in the past four years by Dr. Ellis Fischel, Dr. Earl C. Padgett, and by the writer on patients in whom the latter was directly interested. A definite plan of technic was followed that required about a year to develop and has not been materially changed since.

These operations were performed at the Barnes Hospital, the St. Louis Children's Hospital, and the St. Louis Mullanphy Hospital. This tabu-

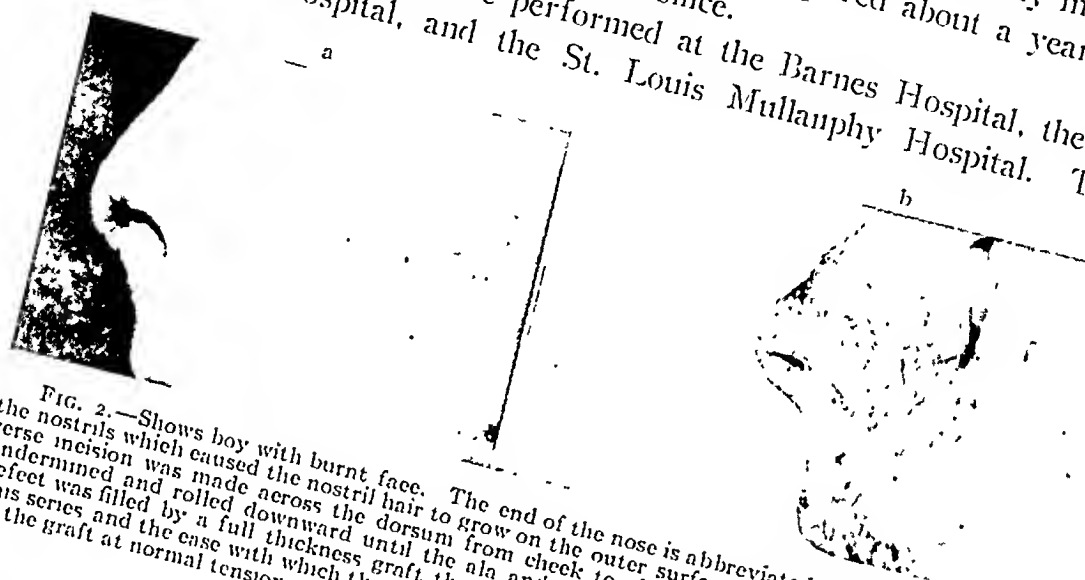


FIG. 2.—Shows boy with burnt face. The end of the nose is abbreviated and there is an ectropion of the nostrils which caused the nostril hair to grow on the outer surface of the ala. To correct this a transverse incision was made across the dorsum from cheek to cheek and the scarred superficial tissue was undermined and rolled downward until the ala and tip were restored. The resulting diamond-shaped defect was filled by a full thickness graft that was sutured in under tension. This was the first case of this series and the ease with which the result was obtained led to the erroneous conclusion that suturing in the graft at normal tension was all that was needed to get 100 per cent. satisfactory takes.

lation does not include quite all of our cases, for in many instances the skin graft was but one incident in an operation and has not always been separately indexed.

All negative statements that may follow are to be taken as referring only to the cases in this series and not to imply that positive results might not be obtained by some other technic or under some other circumstances.

Dissatisfaction with the ultimate results of the "Thiersch" graft when used on skin surfaces was the driving motive. The work as started was based on two premises: First, that if the transplanted skin were held at its normal tension or at slightly plus tension the cut ends of the cutaneous vessels would be held open and would more quickly take up a blood supply; the second, that as each particular part takes its blood supply from the immediately subjacent tissue, the only logical limit to the size of a graft would be the amount of operating and hemorrhage the patient could stand. Subsequent experience justified both of these conclusions. A very free arterial blood supply has been demonstrated by scarifying a graft 48 hours after implantation (Figs. 1 and 2), while numerous subsequent observations have proven

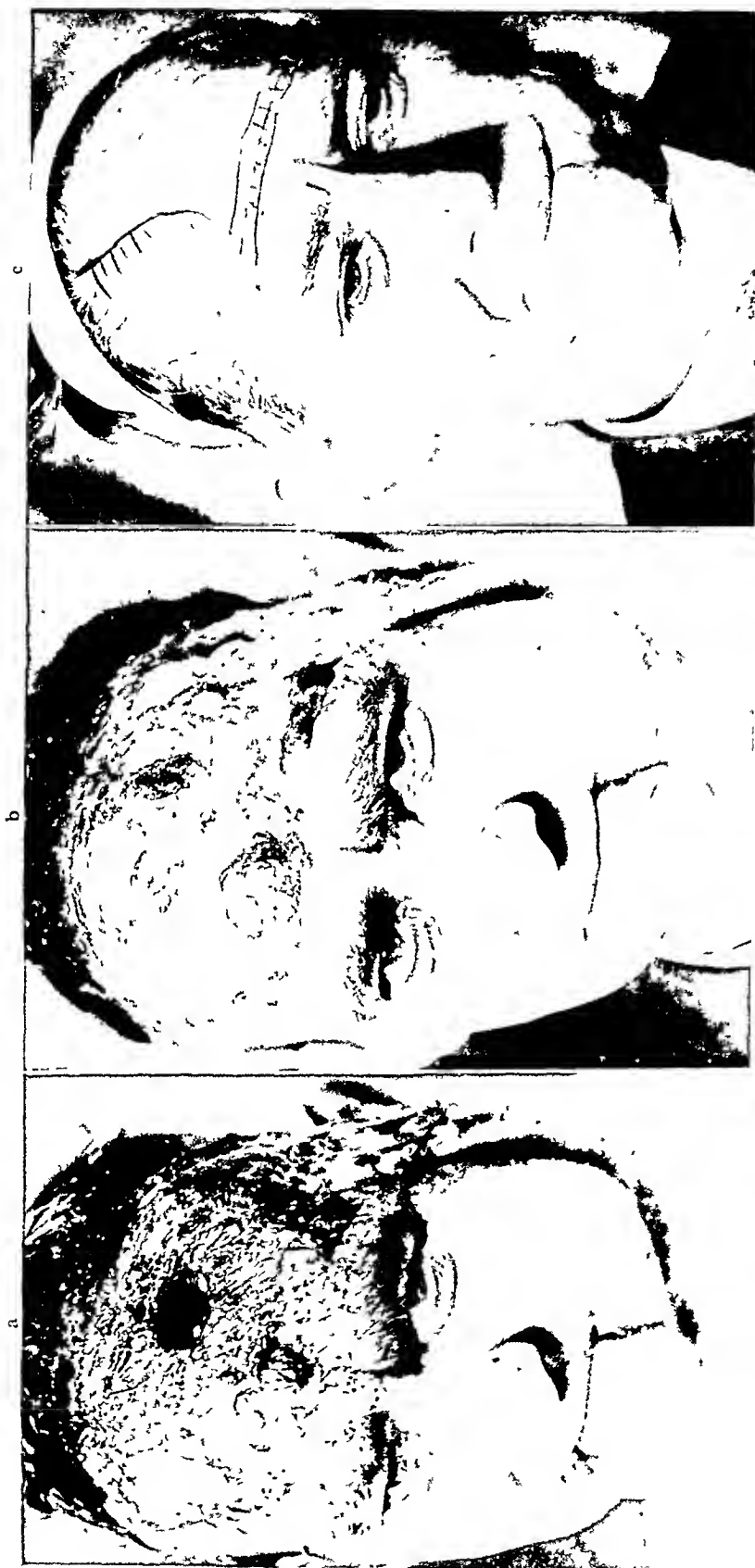


FIG. 3.—Shows defect filled with a $3\frac{1}{2} \times 8$ inch full thickness graft from the abdomen in a man fifty-six years old. This graft was cut by a pattern that was the size of the defect, but instead of the graft contracting, as is usually the case, it stretched so that when it was sutured into the defect it was quite loose. (Operated March 21, 1923.) In (a) taken thirteen days after placing the graft the imperfect "take" is already apparent. In (b) taken twenty-two days after operation the dead skin has been thrown off and the granulating areas are evident. (c) Taken one year later shows the surface healed partly by scar. The cross lines show the arcs into which sensation has been restored, but in the scarred region it has not returned.

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that a graft not on tension is uncertain about acquiring a blood supply. (Fig. 3.)

Very soon after these two hypotheses were put into practice it became evident that there were additional factors of almost equal importance that still remained to be catalogued. Certain of these have since been identified but not without some heart-breaking experiences and the indulgence in considerable worry; others have so far baffled our efforts. The first of these stumbling blocks was a fact long ago recognized in dealing with large thin



FIG. 4.—Shows a full thickness skin graft on the forehead that replaced a "delayed flap" used to reconstruct the nose. The central part of this flap was thicker than the outer part, which left a deeper depression in the centre of the resulting defect. A simple gauze pad was bandaged over the graft and this did not compensate for the lack of counter pressure in the central part. It will be seen that the central part of the graft where the pressure was less has died as the result of venous stasis.

flaps; that it is one thing to have an arterial blood supply and quite another to have an adequate venous return. In the first several cases the grafts were applied to the bridge of the nose or to the forehead. (Fig. 2.) In the former the tension of the sutures drawing the graft over a curved firm surface, and in the latter the pressure of the bandage that held the dressing both helped to limit the amount of blood that could stagnate in the skin while the new venous return was being established. It was not until the attempt was made to place a large graft on the cheek that we were forced to conclude that in the previous cases good luck had outrun calculation. In the particular case in point the retaining dressings were removed at the end of two days for fear mouth secretions might seep under them and the newly adherent graft was left exposed. Within a few hours the pale pink skin became deeply blue and repeated scarifications, carried on night and day, and citrate of soda packs failed to save us from the painful necessity of explaining to the patient the loss of seven-tenths of a 3 x 4 inch graft. Three months later, after shaving off the granulations, another graft was applied, but this time it was



FIG. 5 (a, b, c).—Show three stages of a graft, 70 per cent. of which was lost from excessive pressure. This was one of the very earliest cases in which the sponge pressure dressing was used and it was put on so tight that the face was dusky from venous congestion. (a) The first picture, taken the day after the original dressing was changed, shows much of the graft dark and inelastic but adherent. In (b), taken two days later, the most superficial layer of epithelium has peeled off, showing a patch of pink, live skin. In (c), taken twenty-two days after operation, the dead part of the graft has been thrown off, leaving a patch of live skin and a granulating surface. The submaxillary and submental graft, which was not subjected to so great direct or counter pressure, survived.

protected by dressings held in place with a pressure bandage. That part of the graft survived which lay over a wax form in the hollow of the cheek which furnished counter-pressure. (Fig. 4.) Based on this experience a marine sponge pressure dressing was evolved which, if carefully applied and made of sponges of proper quality, will maintain an even pressure over an irregular surface or one without underlying bony counter-support. Further use of this pressure dressing demonstrated an unforeseen virtue and an inherent danger. It permits of the application of the graft over a freshly made raw surface, such as results from the removal of a scar, without tying any but large vessels, but if the pressure is too great, especially over a bony prominence such as the outer part of the supra-orbital ridge or dorsal surface of the middle metacarpal bone, it can kill the

compressed area by ischæmia. (Fig. 5.) Maintenance of the proper pressure for four or five days will prevent the graft from dying from engorgement, but its early discontinuance favors the formation of blebs, which latter may lead to

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another catastrophe. (Fig. 6.) The blebs are apt to become infected, sometimes at least, from organism contained in the skin. If this infection is not controlled, the resulting ulceration may not stop until it has eaten through the full thickness of the skin. This ulceration seriously marred a number of our earlier final results, and in many of our later cases we were only somewhat less bothered by it. Dr. Martin Engman, while seeing one of these cases in consultation, advised painting the infected base of the bleb with a 1 per cent. silver nitrate solution. We have since continued its use and I think it greatly helps to control this ulceration. Also to help control this infection and to prevent the dressing from sticking, a layer of gauze impregnated with 3 per cent. xeroform ointment is laid on the graft under the pressure dressings. The use of this ointment is continued as long as dressings are deemed necessary, and it is certain that our later results are much less marred by scars resulting from patchy destruction of the epidermis than are our earliest cases; however, this source of error has not yet been entirely eliminated. Very recently, to control this superficial infection, we have in several cases used for the later dressings a 2 per cent. boric acid pack under impervious dressing apparently with somewhat more promising results. (Fig. 20.)



FIG. 6.—Shows the blebs that form after the too early removal of the pressure dressing. These blebs may form under the pressure dressing, but are not apt to be so extensive nor so troublesome.

Blood clots of any size will cause the death of the overlying skin. It is impracticable to tie all or sometimes any considerable number of the bleeders after the removal of a burn scar, but properly graduated sponge pressure following appropriate puncturing of the graft with a fine leather punch, as advocated by Davis, or with a knife, and carefully squeezing out all clots before applying the pressure dressing will do much to eliminate this source of disaster. A "Thiersch" graft can be wrapped around a wax form and buried in the tissues with every expectation of a perfect "take," but our observation leads to the belief that the full thickness graft requires some ventilation during the first few days after it has been transplanted. This conclusion is based on the following experiences: Several times a rubber bath sponge was used in place of a marine sponge; in one case the outside dressings were all covered thickly with vaseline to prevent the possibility of vomit

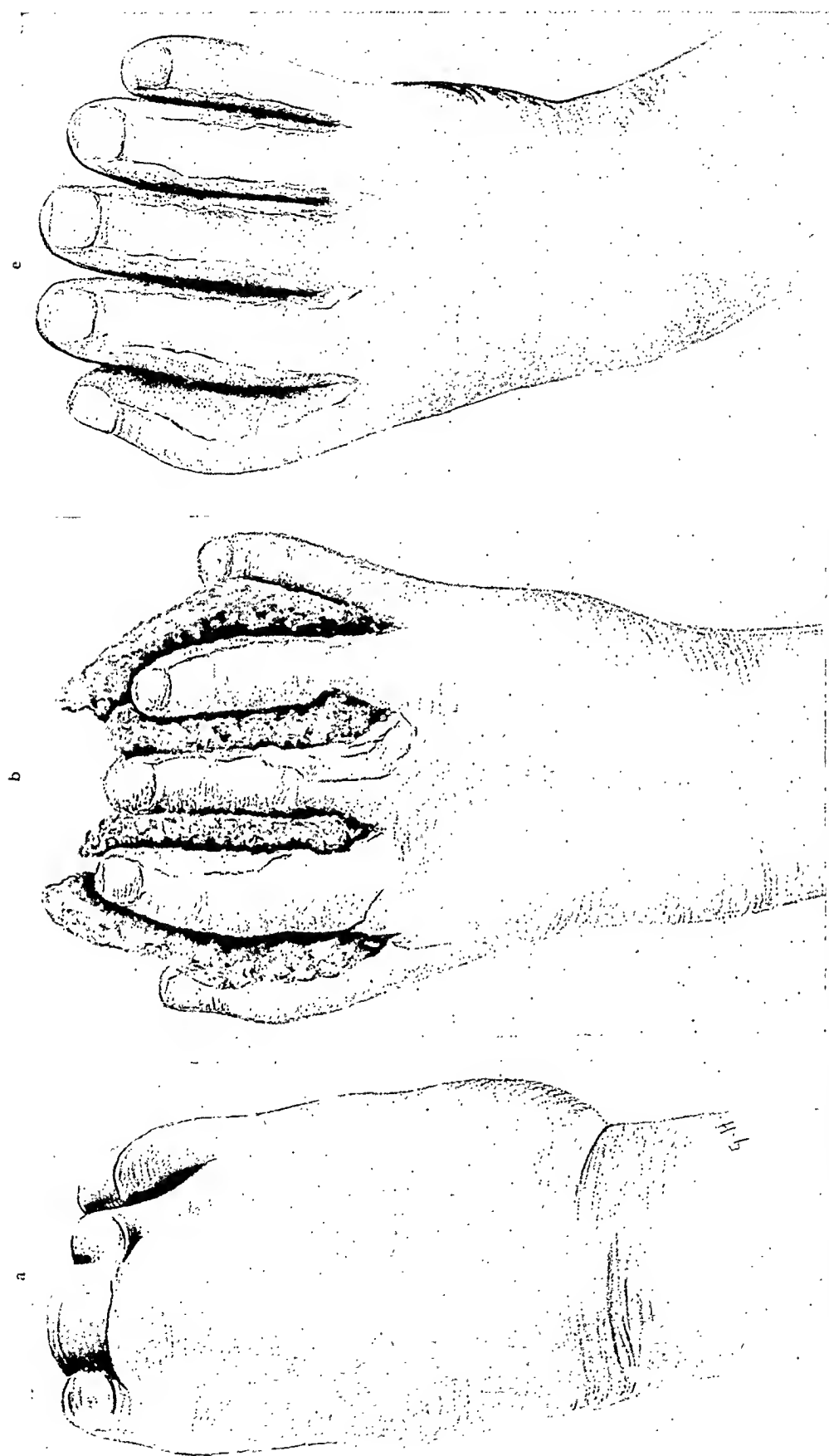


FIG. 7.—Shows a complete syndactylism in a five-year-old boy in which the two outer elefts were lined with full thickness grafts and the two inner with "Thiersch" grafts. All were sutured in place, the whole operation requiring one hour and ten minutes. The elefts were cut as deep as could be without dividing the transverse metacarpal ligament, but the grafts contracted so that it was advisable to again deepen the elefts and regraft approximately 8 months later. At this time the full thickness grafts had contracted considerably less than had the "Thiersch."

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soaking into the marine sponge; in another case the full thickness graft was sutured around a wax form under normal tension and buried in the floor of the mouth through an external incision, and in still another a very soft old sponge was put on with such pressure that it made an almost impervious casing. In the above cases much or all of the grafts macerated and a considerable part of each graft was lost. The observations of Allen Kanavel and J. Staige Davis do not seem to support the preceding. The former fixes small

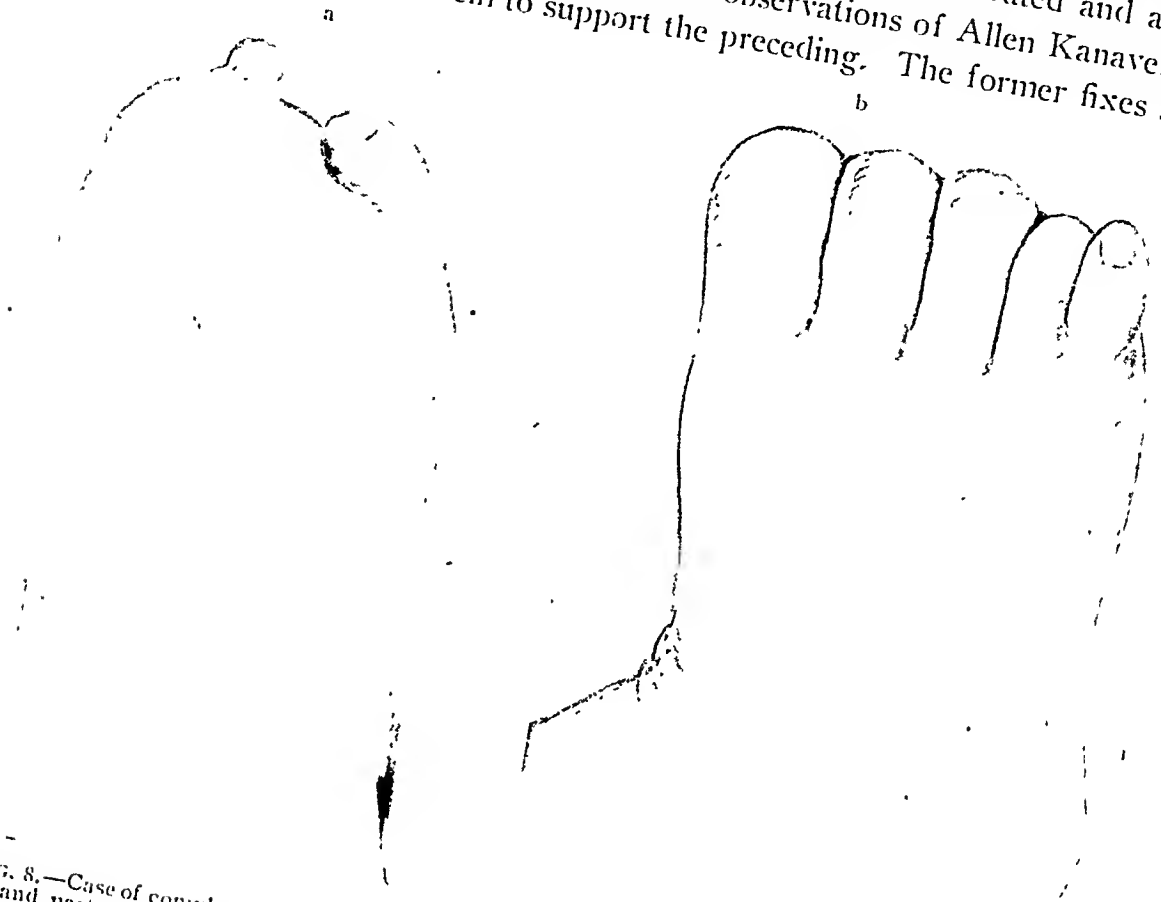


FIG. 8.—Case of complete syndactyly of the foot. Here part of the clefts were lined with "Thiersch" grafts and part with full thickness. Note how, after freeing the toes, the foot flattened out to form a usable member. In this instance the subsequent contraction, though quite as great as in the preceding, did not interfere with function.

grafts under wax forms and the latter buries full thickness grafts under delayed pedicle flaps sometime before transplanting the flaps. There may be still other causes that produce local areas of "death" of the graft and upon this subject we are still seeking light.

The shrinkage of the graft bears no proportion to the amount of contraction that occurs in a "Thiersch" graft. If the epithelium is preserved, the contraction will be not more than would occur in the healing of a pedicle flap of the same size. If there is more than a very superficial loss of the epithelium, the area from which this loss occurs may contract one-half or more. (Fig. 19.) In some localities, as the forehead, this normal contraction need not be considered, in others compensation must be provided beforehand or made subsequently. This can be done in some areas by doubling back the

skin bordering the defect at the time of operation (Figs. 10 and 11), in other instances an additional graft or a flap has been inserted to release the tissues displaced by the contraction. (Figs. 17-19.) On the hand or axilla, splints used for three weeks will help control contraction (Fig. 13) and the lips or eyelids can be supported either by uniting the corresponding fellows, by suturing newly made raw surfaces, or by suspension sutures (Fig. 19).

The final color of the graft is a thing that we cannot foretell, except that in a general way the darker the complexion the darker is apt to be the tan that will come in the graft. Normally, the abdominal skin has a yellow tinge, but this does not account for the tanning that occurs to a greater or less

extent in the majority of full thickness grafts. On "white" negroes this tanning may be very dark. Usually the tan is evenly distributed but sometimes it is blotchy (Fig. 16 c-d); where the graft does not tan it is apt to be pale or white (Fig. 16 a-b). In some cases the trans-



FIG 9 —Shows the partial result that followed the removal of the scar, straightening the finger and covering the raw surface with a full thickness graft in the case of a contracted burn scar. No allowance was made for the subsequent contraction of the scar surrounding the graft and the result can be rated as only a partial success.

planted skin will become more pink than it was in its natural position and match the face skin fairly well; tanning appears somewhat late.

In a general way, age has been an influencing factor. As a rule the younger the patient the more certain is the graft to "take" completely and the more natural will be the appearance. However, in a man seventy-nine years old who had a $4\frac{1}{2} \times 6$ inch graft transplanted from the abdomen to the forehead the color and texture were so perfect that it could not be detected by any casual observation. The youngest in this series were two infants grafted for complete syndactylism at the age of one month each. In the adult, and even in young children, these grafts are as resistant to contamination at operation as any healthy tissue, but should infection occur it is apt to be very destructive to the graft itself. At many of these operations it is practically impossible to keep the field clean. In the infant and young child a pus infection may very rapidly destroy large parts of an already adherent graft within the first few days after operation, and this is most apt to occur when

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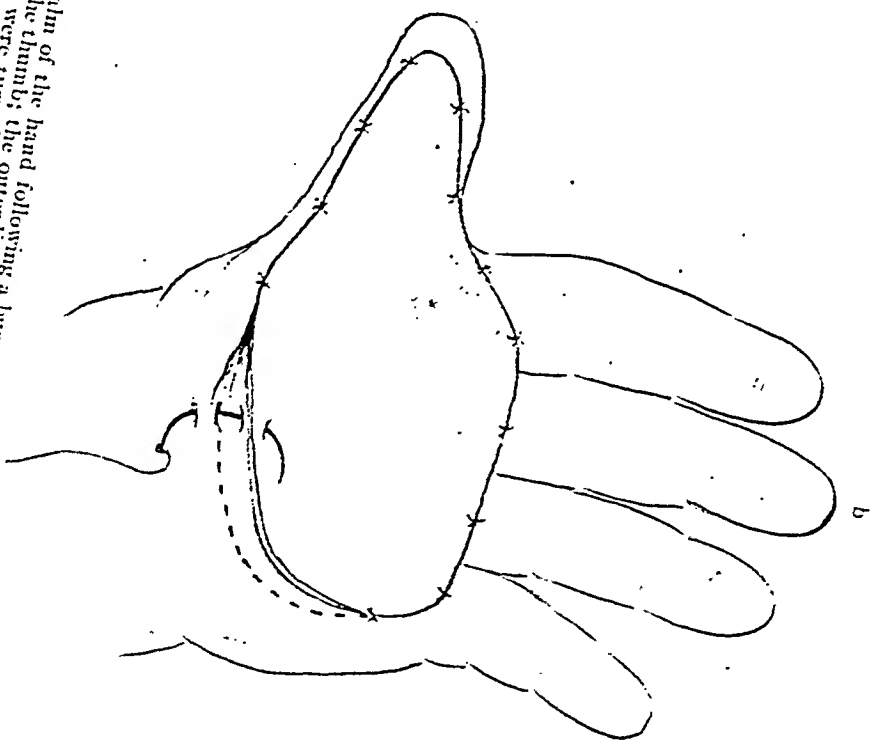
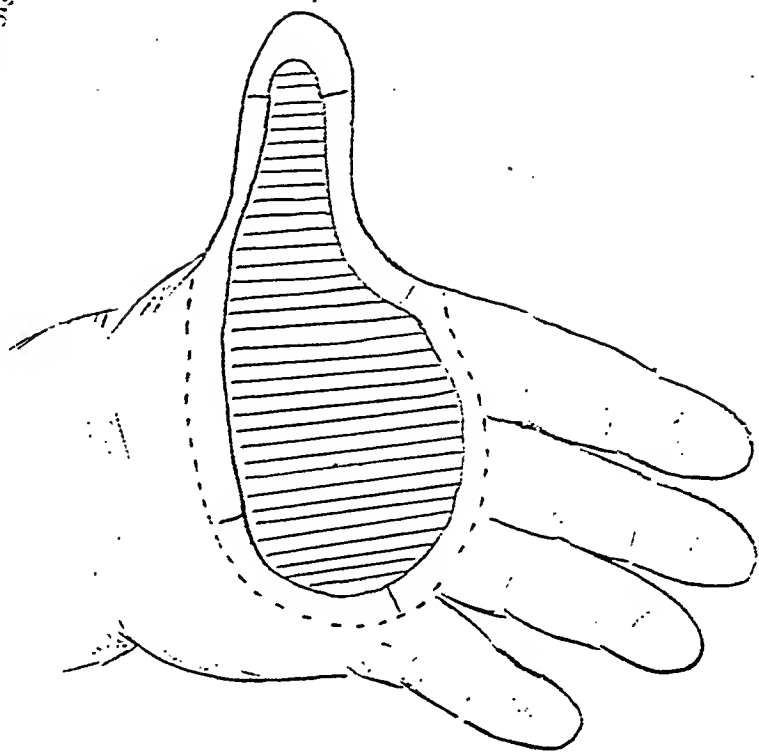


Fig. 10.—Case of complete adhesion of the palmar surface of the thumb to the palm of the hand following a burn. The striped area in the surrounding skin shows the extent of the raw area that resulted from the freeing of the thumb; the outer lines indicate the extent to which the graft then through the everted skin edge, and then took a turn through the undermined edges were turned outward, skin surface to skin surface, so that thickness of gauze and sponge is simply handaged over the whole. Compensation can be made by filling the depressed central part by several layers of xeroform gauze cut to accurately fit within the elevated edges. When the sutures are removed after following this plan, at first the flattened area is surrounded by a ridge, the outer surface of which is formed by the everted skin, the inner surface by the graft. This subsequently flattens out. If any did remain it could be removed after one was sure that the redundant skin was not needed. In cutting the graft for this plan it is made the same size as the raw area when the undermined edges are everted.

the original dressing has not yet been disturbed. It has, however, been our observation that grafts on the infant and young child acquire an immunity to infection earlier than do the grafts on the adult. On the latter the graft seems to be more apt to weather the first week, but is very susceptible to superficial infections occurring under the scarf skin which become manifest in the second or early part of the third week. Such infections can in a few days destroy or very much cripple a previously perfect graft. (Fig. 20.) In one three-year-old child who at the time was not under close obser-

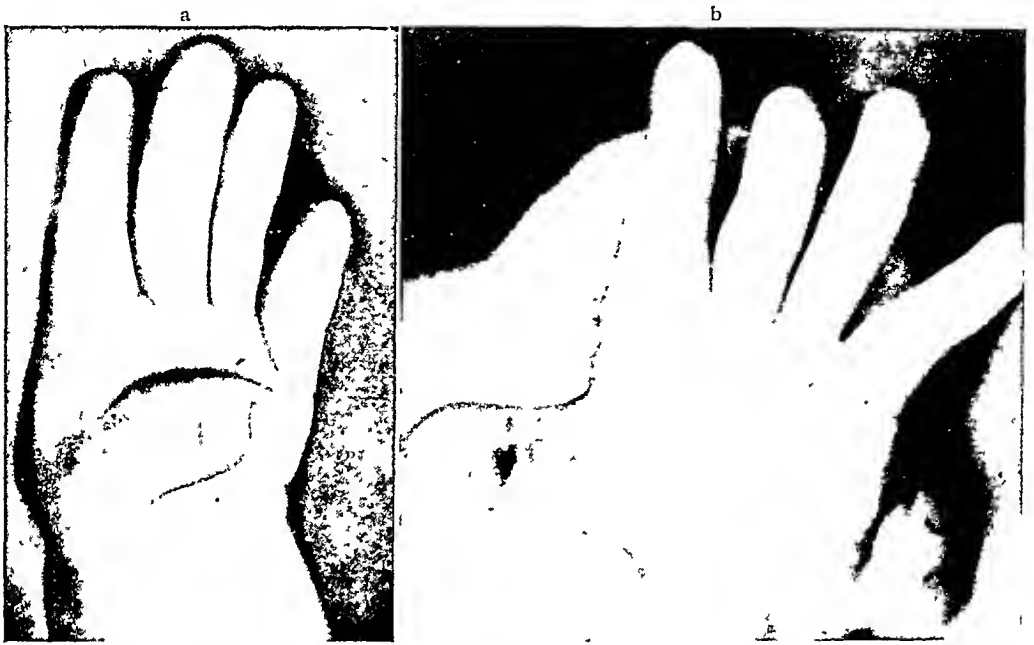


FIG. 11 —Shows case illustrated in Fig. 10. To the left is seen the thumb united to the palm while the photo on the right shows the final condition. Note that the ridges of superabundant skin have disappeared but that the thumb is completely freed.

vation, a destructive ulceration attacked a forehead graft in the third week after operation.

On two cases a graft was transplanted from the mother to the child; in one the blood matched and in the other it did not. In each it was controlled by an auto-graft made at the same time and in each, at the end of the first week the homo-graft appeared to be a perfect "take," even smoother than the auto-graft. In the second and third weeks, however, the homo-grafts macerated and were thrown off while the auto-grafts made good. (Fig. 12.) This is contrary to some reported experiences. Dr. M. T. Burroughs suggested to us that difference in age between mother and child may have been a factor in the failure. John Staige Davis, J. C. Masson (*Jour. A. M. A.*, June 1, 1918), H. K. Shawan (*Amer. Jour. Medical Science*, April, 1919), and others have reported success with the homo-graft, while R. Minervini (*Transactions Medical Congress, Jour. A. M. A.*, September 6, 1913) used the skin of non-diseased still-born babies and his reported success in this might have some relation to our observation that the younger the child the

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more satisfactory the "take." It would be a great blessing in certain burn cases of young children if the skin could be obtained from some other source. The individual grafts varied from $1\frac{3}{4}$ to 42 square inches. We have



FIG. 12.—The photograph above shows a child with both arms bound down by scars in and below the axilla while the lower one shows them released after incising the scars, abducting the arms, and covering the raw surfaces with full thickness grafts. At the first operation both arms were freed. In the right axilla a full thickness graft from the mother, whose blood matched with the child's, was implanted while on the left a graft from the child was used. The subsequent behavior of these grafts is detailed in the text. At a later operation the right axilla was regrafted from the child.

found that the transplantation of about 40 square inches of skin approaches the practicable limits of the operation, especially when this step is just a part of one operation. The following tables give a résumé of our work:

VILRAY P. BLAIR

Indications	Number	Average per cent. of success
Replace delayed flap	34	79.70
Replace immediate flap	2	90
Release or replace burn scar	57	77.87
Replace eyebrow	7	87½
Release ear	3	66⅔
Web fingers	4	76½
Web toes	1	90
Release Dupuytren's	1	90
Scar	1	75
Replace nevus	1	80
Luetic scar	2	67½
Release tongue	1	0
Replace scalp	1	90

Location of graft	Number	Average per cent. of success
Forehead	38	81.32
Cheek	8	58
Eyelid	4	85
Dorsum of nose	2	85
Neck and chin	12	68
Hands—dorsum	10	83½
Hands—palm	9	83⅓
Finger clefts	5	76
Axilla	3	80
Popliteal space	2	70
Floor of mouth	1	0
Toe clefts	1	90
Arm	1	80
Neck	3	85
Eyebrow	7	87½
Ear	2	55
Forehead and scalp	3	86⅔

Tissue on which graft was bedded	Number	Average per cent. of success
Periosteum of forehead	31	78.70
Subcutaneous tissue	13	76.53
Subcutaneous and burn scar	57	77.28
Heavy scar	1	50
Partly on tendon	5	90
Partly on cut bone	2	90
Luetic scar	2	62½
Tissues below floor of mouth	1	0
On a granulating surface	1	80

Number of graft operations 106
 Average per cent. of success 77.41 per cent.
 Number showing 90 per cent. success.... 58
 Average size of grafts..... 8.43 square inches.

These estimates are, of course, somewhat approximate, though all grafts were cut from tinfoil patterns. As a margin of safety in making estimates, no graft was given credit for more than 90 per cent. "take." Where provision for shrinkage or loss had been made a part of the operation, then

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a



b

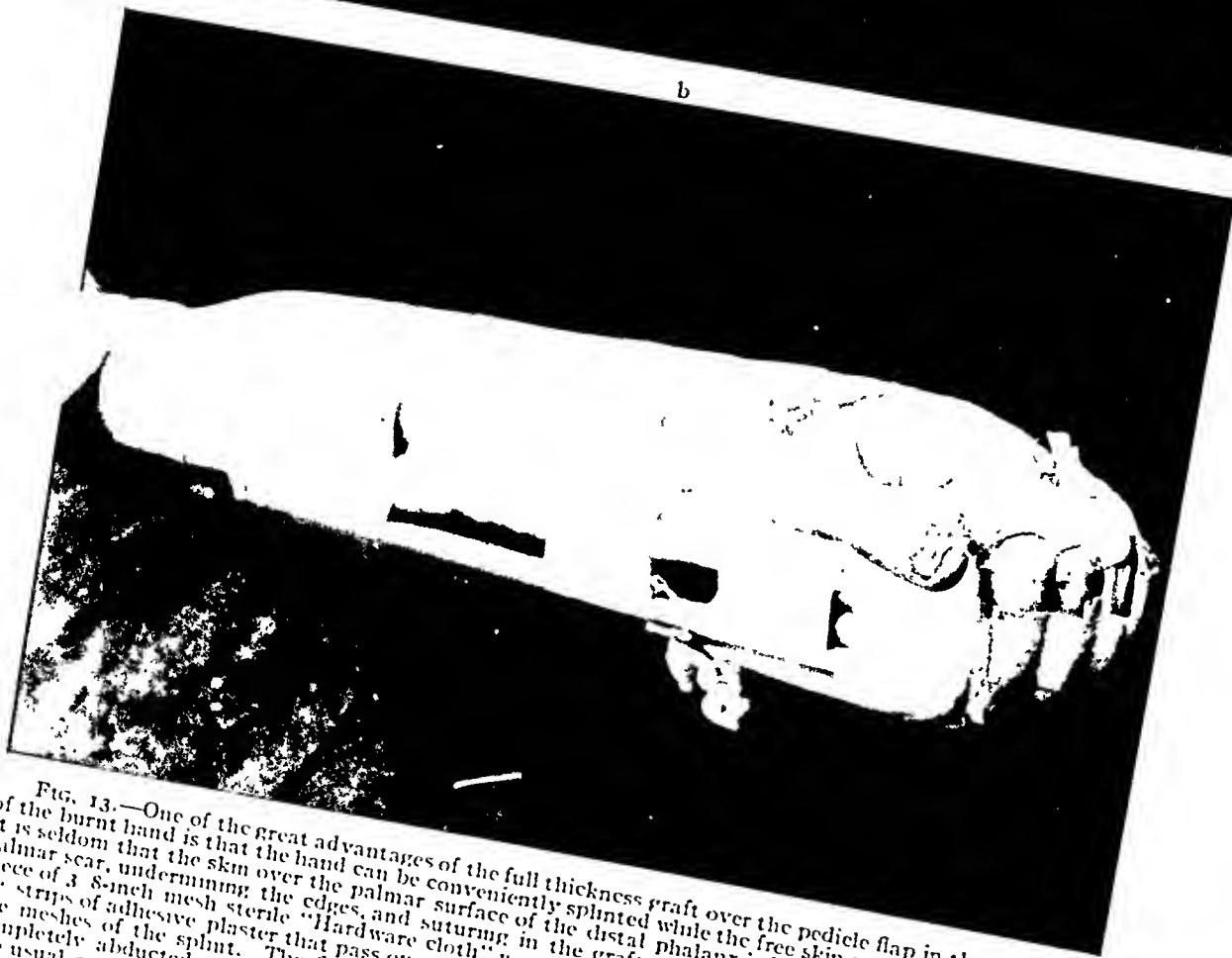


FIG. 13.—One of the great advantages of the full thickness graft over the pedicle flap in the restoration of the burnt hand is that the hand can be conveniently splinted while the free skin graft is healing in place. It is seldom that the skin over the palmar surface of the distal phalanx is involved. After removing the palmar scar, undermining the edges, and suturing in the graft after the plan shown in Fig. 10, a folded piece of 3/8-inch mesh sterile "Hardware cloth" is appropriately padded and the hand is held extended by strips of adhesive plaster that pass over the distal segment of each finger and which are tied through the meshes of the splint. The fingers should at the same time be somewhat separated and the thumb completely abducted. One or two adhesive straps around the forearm complete the fixation after which the usual sponge pressure dressing is bandaged in place. It is well to reinforce this wire splint by bandaging a light board on the dorsal surface after the dressings are applied. We had one graft damaged some days after operation by a fall in which the splint bent. (a) Shows this wire splint applied. The extensors tendons may have become fixed in a burn scar of the dorsum and these can be released when the scar is removed so that the fingers can be flexed. The graft should be patterned so that it will cover the defect with the hand flexed and the hand should be splinted in this position, shown in (b), and this should be continued for some weeks.

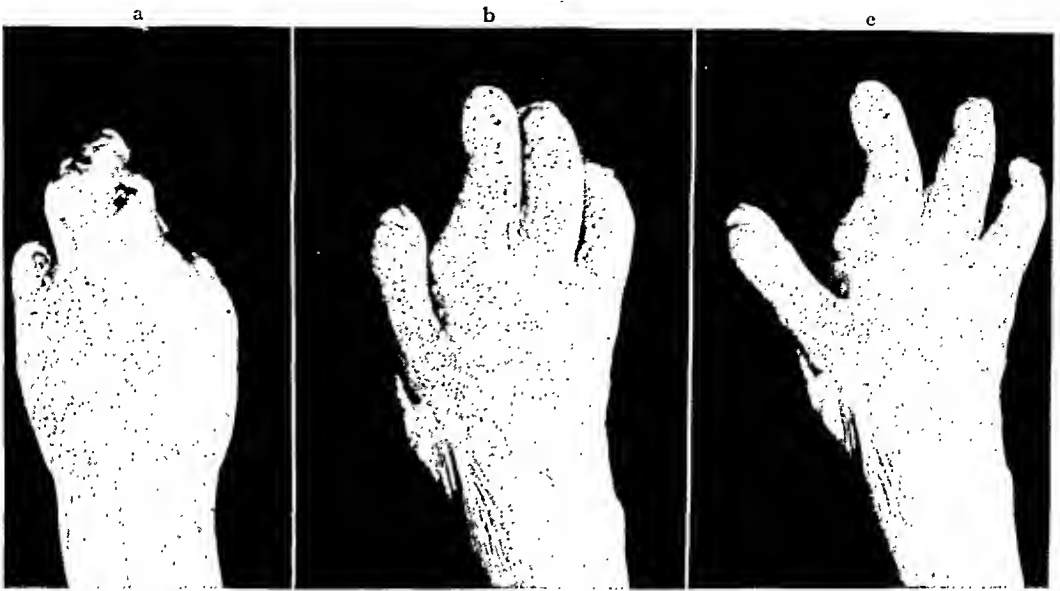


FIG. 14.—The photograph to the left shows a hand burnt on all surfaces with the fingers scarred into one mass resulting from a burn that involved the dorsum and the interdigital spaces. The dorsal skin was restored by removing the scar and planting the hand and fingers in pockets tunneled just under the skin of the lower abdomen. Later the interdigital spaces were epithelialized by full thickness grafts. Figure (b) shows the restoration, figure (c) shows the ability to abduct the fingers.

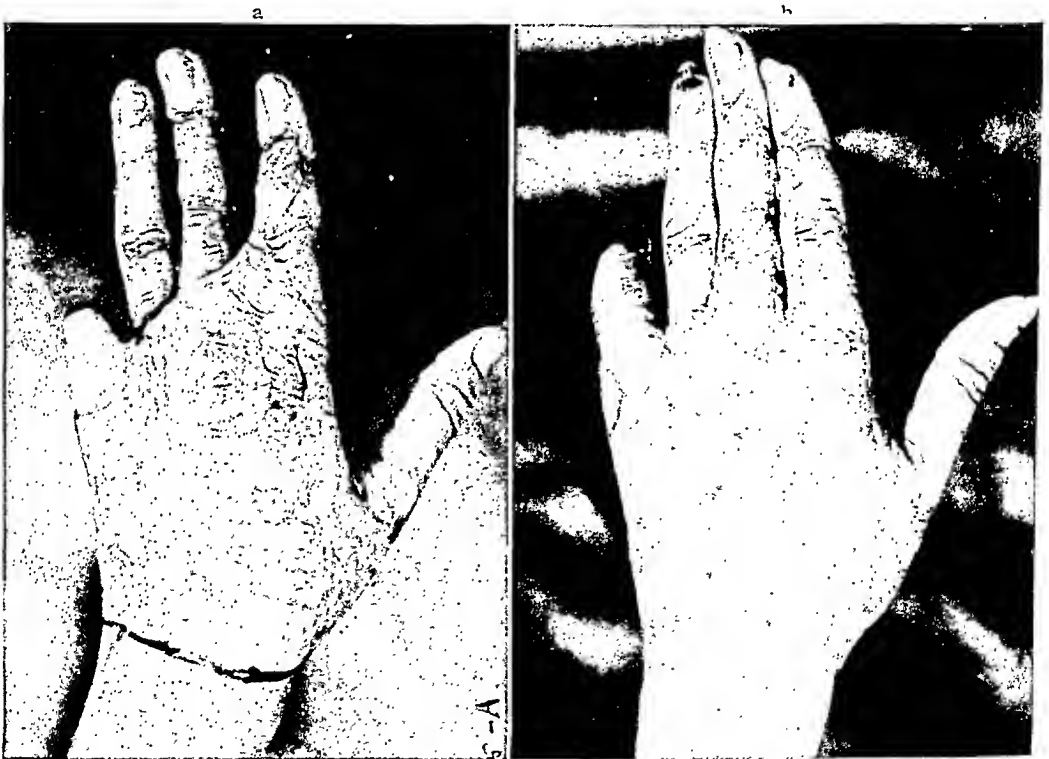


FIG. 15.—Shows the rough scar resulting from a burn sustained years previously. The whole scar was dissected off and the defect covered with one full thickness graft from the abdomen. Figure (b) shows the graft which "took" throughout. It is of good color and texture.

the final result, not the amount lost, was taken as the basis in making the final estimate of success. Many of these grafts took perfectly, and except for the bordering scar and a slight tanning and shiny appearance the skin

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substitution could hardly be detected. In most localities a graft can be so placed as to allow for 25 per cent. shrinkage.

Most of the grafts were taken from the abdomen, but of necessity came from the thighs or sides, and two were taken from the back. No attention was paid to matching the direction of the cleavage line of the skin, though possibly this might in some way have some influence. It seemed that the thin skin "takes" more kindly than thick.

Seven of these grafts were taken from the scalp to replace lost eyebrows, and we have in some cases, not included in the above series, transplanted free grafts from the eyebrow to replace eyelashes. In replacing eyebrows the scalp rather than pubic skin has been used for the reason that the hair on the former



FIG. 16.—(a) Shows a lady on whom the nose and upper lip were remade from a flap taken from the neck and the tissue behind the ear. (b) This was replaced with a full thickness skin graft from the abdomen. In this case the "take" and texture were very good but the skin grafted is very much whiter than that of the neck. (c) Shows a young woman who, on account of a recurrent carcinoma, had part of cheek and upper lip reconstructed from a delayed flap taken from the forehead. The forehead defect was filled by a full thickness graft from the abdomen, satisfactory in "take" and texture but which has become very darkly tanned. The girl is naturally of a dark swarthy complexion (d).

grows more closely and an accurate selection can be made as to the direction in which the hairs grow. It is true that the hair on a scalp graft must be trimmed at intervals, but that might be true of pubic hair, and the plan of growth of the latter resembles eyebrow less than does the scalp hair. Law, of Minneapolis, has mentioned one case in which an otherwise successful pubic graft had to be removed on account of embarrassment arising from the self-consciousness of the patient.

Its Place in Surgery.—The four most appropriate uses we have found for the free full thickness skin graft are the release of scars on the neck and axillae, the replacing of burn scars on the hands, neck and forearms, to replace flaps that have been taken to repair other defects and to furnish skin to line clefts in congenital or acquired syndactylism.

In these uses it can be compared with the pedicle flap and the "Thiersch" graft about as follows: The former when properly handled is more certain to complete success, and if taken from the neighborhood is apt to have a better color. Where subcutaneous tissue is also desired, as over the bearing surface



FIG 16.



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of a bone that is covered only by scar, the pedicle graft is more appropriate. The final result of the pedicle flap is often greatly compromised by the excess of subcutaneous fat that is included. This is most noticeable with flaps transplanted to the hands or fingers. The question of the possible subsequent increase of fat in the transplanted flap concurrent with a later general increase of the fat has not, as far as known, been settled. The "Thiersch" graft is also more certain of taking, the technic of its use is less exacting, and it can be applied within the mouth as well as on a clean skin surface. On the other



FIG. 17.—(a) Shows appearance of child shown in Fig. 18 after 50 per cent. of the first graft had healed in place. (b) Shows the case after a second strip of skin had been recently grafted above the upper edge of the first. The completion of this case is shown in Fig. 18 (b).

hand, its subsequent contraction is many times greater than a successful Wolfe graft and its color and appearance is not as good.

The full thickness graft is somewhat uncertain of result, is exacting in its technic, requires three weeks before it can be considered safe, and in children and young adults may develop red corded scars, months after an apparently perfect take, yet it has a place in surgery that is not as well filled by either of the two preceding.

The Technic.—The technic was as follows: The graft is usually implanted either in the bed from which a flap or a scar or growth has just been removed, or in the space that results where a tight area of skin or scar has been incised and released. The bleeders are caught and, where practicable, tied with fine silk, preferably white. A pattern accurately reproducing the shape and size of the raw surface is cut from a piece of sterile tin-foil and the side corresponding to the epithelial surface is indicated by writing on it with a blunt instrument the name and date. This has proven to be important. The skin from which the graft is to be cut is painted with 5 per cent. picric acid in alcohol which is later sponged off with alcohol. The tin-foil pattern is laid



FIG. 18.—Shows a child who as a result of severe burns had the mucosa of the lower lip attached to the chest 1 inch below the upper border of the sternum. It required three separate operations to obtain the result shown in (b). At each of these operations full thickness grafts from the abdomen or thigh were implanted. A total of 50 square inches of skin being transplanted. Eighty per cent. of which "took"—color good.

on the skin, epithelial surface up, and the outline very accurately marked by a knife cut which immediately, or later, is made to go through the full thickness. Allis or small Ochsner forceps grasp at intervals along the edge of the skin at the end of the outlined graft, while with a very sharp knife the skin is released from all subcutaneous vessels and tissues, cutting always where the junction of the skin with the subcutaneous tissue is most tense. The under surface of the skin should show white and stippled with little pits and should show no bleeders. The graft is given in charge of an instrument nurse who places it in a pan, folding it so that raw surface is to raw surface and the whole covered with damp gauze. When it is to be used one assistant grasps an edge with an Ochsner or Allis forceps and is responsible for it until the graft is safely tacked in place. This bit of formality may save the embarrassment of losing the graft among the discarded sponges or of dropping it on the floor.

The graft is usually punctured and then

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sutured into its new bed with a continuous horse hair, first tacking it in a few places to assure accuracy of position and even tension. If the vessels of this bed have not been tied, as may be the case in a burnt area, bleeders must be controlled between the removal of the forceps and the application of the pressure dressing by sponge pressure or an Esniarch bandage. Just before the final dressing is applied the clots are pressed from under it by firmly rolling



FIG. 19.—Shows a child on whom a sear of the lower lid and cheek, due to congenital infection, was replaced by a full thickness skin graft from the abdomen. In order to hold the denuded lower lid on tension while the graft was healing in place, a small raw surface was made in the middle of the upper lid just above the tarsal border and a projecting tab of graft was made to jump the palpebral fissure, tarsal border and eyelashes to be planted on the upper lid. This strip of graft "took" perfectly and can be seen in the figure. The part included within the dotted outline in (a) shows the amount of sear actually removed while the everted mucosa above this was undermined and turned upward, thus increasing the raw surface to be grafted to the extent shown in the striped area. A superficial ulceration caused the subsequent loss of some epithelium with a resulting excessive contraction of the graft, which necessitated the subsequent addition of a pedicle flap from the forehead to the lower lid. Finally the skin bridge across the tarsal fissure was cut and the piece removed from the upper lid.

over the surface a roll of gauze, the surface is then covered with several layers of gauze impregnated in 3 per cent. xeroform ointment. Over this is applied a large soft, damp marine sponge which is bandaged in place with some pressure. The quality of the sponge and the tension on the bandage are important factors.

If the vessels have not been tied and the bandage pressure is depended

NOTE.—We use a good quality of bath sponge which when dry is about $1\frac{1}{2}$ inches thick by 4 x 5 inches in diameter. These are washed, soaked in an antiseptic, rinsed, dried, and put away in a jar. When to be used they are wet with saline and wrung out as dry as possible in a towel. Sponges may be cleansed and used repeatedly, but when they lose their elasticity they must be discarded.

upon to control the bleeding, it is well to put an inner bandage over the sponge at the tension it is desired to maintain until the first redressing, and over this place a much tighter bandage that is to be removed in three or four hours.

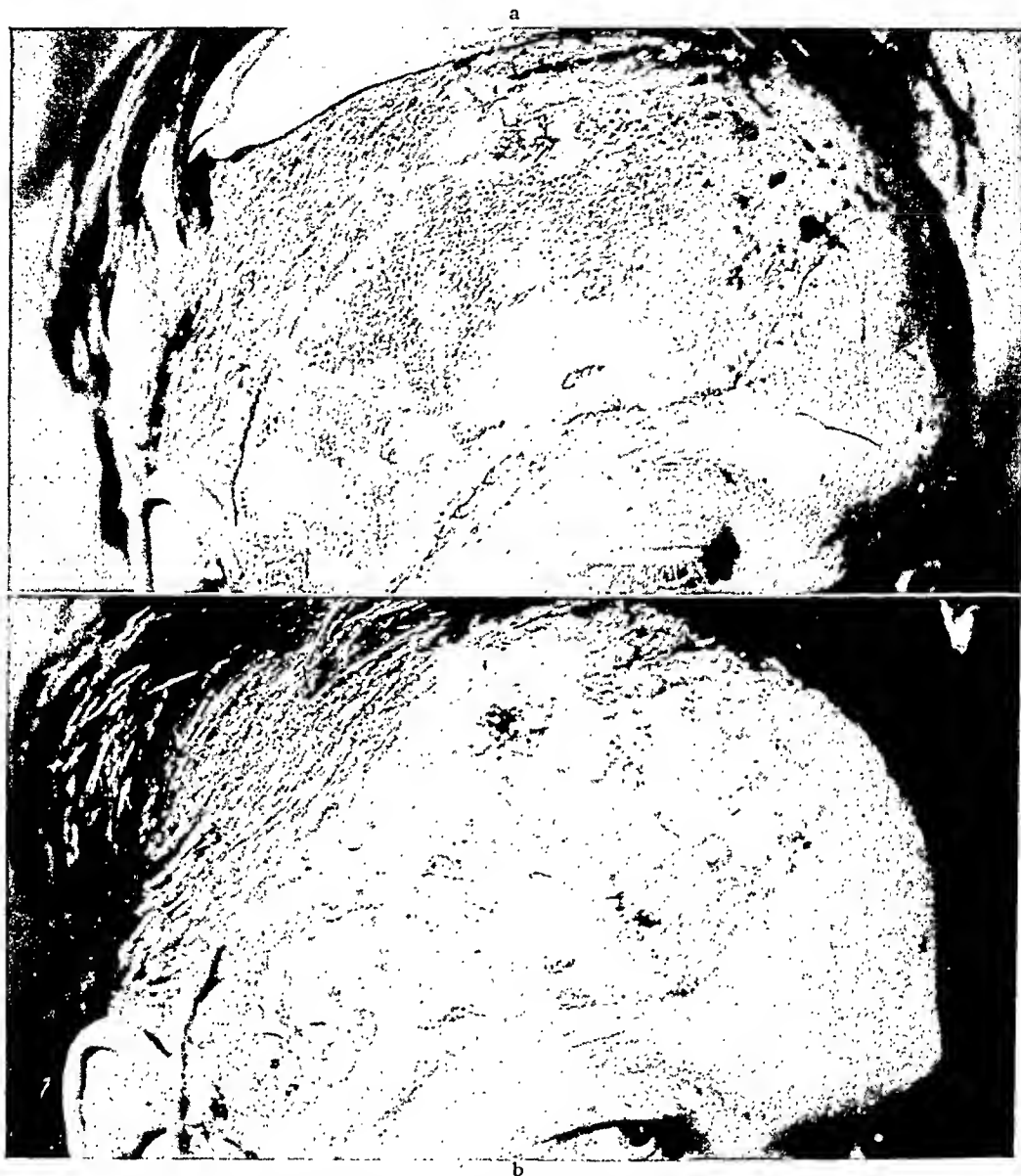


FIG. 20.—(a) Taken on the 12th day after operation shows a full thickness graft that was practically perfect at that date. Up to this time the graft had been dressed with xeroform ointment on the gauze. The ointment was left off and a dry dressing was applied for but 24 hours. (b) Shows the same graft one week later. A superficial ulceration has spread over about one-half the surface and in two small areas has gone completely through the epidermic layer. A 2 per cent. boric acid, moist pack, frequently changed, was used which controlled this superficial infection. The xeroform or the boric acid may be of some help, but what really accomplished the result is the ointment or the wet pack which prevents the formation of crusts that harbor bacteria. The discolored appearance in (a) is due to xeroform, which turns dark after a few days.

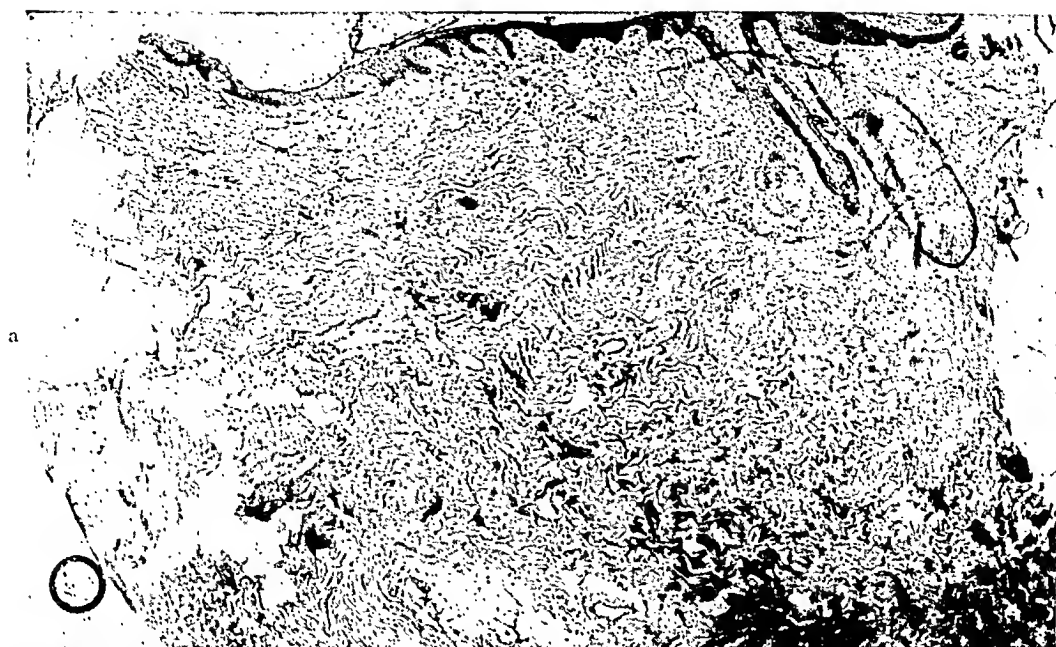
The sponge pressure of the permanent dressing should be firm but not sufficient to cause ischæmia of the graft. One's surgical sense may be severely taxed in figuring this out. Blood seeping into the sponge can make the pressure greater than it was when the bandage was applied. All gauze

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dressings should be laid on smoothly, the sponge should be soft and the gauze not wrinkled during the bandaging, as patterns of damaged epithelium have been observed that seemed to correspond to wrinkles in the gauze dressings.

The space that furnished the graft may be treated in one of several ways. At first we excised the fat, undermined the edges and obliterated it with sutures. This causes additional bleeding and delay, and should the sutures not hold the scar will be fixed to the aponeurosis or muscles. Now we simply approximate the borders with silkworm gut and either plicate the raw surface with the suture or undermine the edges by thrusting a dissecting scissors and opening them as they are withdrawn. This causes little bleeding. It is always safe to drain the wound at intervals. If the defect is too large to close, it is "Thiersch" grafted from the thigh with or without encircling it with a purse-string suture.

If satisfied as to the asepsis, the original dressing can remain undisturbed for three weeks, but usually it is safer to look at a graft on the young child or infant in five or six days and the adult's in seven or nine days after operation. If the pressure dressing is for any reason removed before these dates, it should be replaced in the same manner as at the original operation. Where mouth secretions or vomit are apt to soil the dressings, a dam composed of rolls of vaseline gauze may be plastered to the lip at the edge of the dressing. Leaving off the pressure dressing at too early a date favors the formation of blebs, which in turn predispose to ulceration of the epithelium. The base of blebs that have or threaten to become infected are painted with 1 per cent. silver nitrate once a day and a xeroform ointment dressing applied. It is not safe to use a dry dressing. The dressing problem is very much simpler if the child has not been hurt by pulling off dressings that have stuck. Of late, as already stated, a boric acid pack has been used for the later dressings on infected cases which seemed to clear off the slough and stop the infection quicker than did the silver and ointment. If a moist dressing is used, it must be kept moist. Lost areas of epithelium can be replaced with "Thiersch" graft put on under pressure as soon as the slough and infection have cleared up.



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FIG. 21.—Histology of Auto Grafts of Skin.—In making a study of the histology of skin grafts Dr. Earl C. Padgett found that the most complete, recent report was from "Transplantation of Tissues," by Harold Neuhof, D. Appleton & Company, 1923, and is taken to be a résumé of the present ideas in regard to microscopic appearance of transplanted skin. He states that within five or six hours after transplantation there is an exudate of fibrin from the wound fixing the transplant in place. This fibrin layer soon becomes infiltrated with leucocytes and disappears gradually to be replaced by a richly vascular connective tissue containing many round cells. The granulation tissue has changed into an organized membrane at about fourteen days. Within a few hours after the graft has been applied, leucocytes of the fibrin layer migrate into its interstices and are also to be found in the lumina of its empty blood-vessels. Most of the blood-vessels in the transplant degenerate. By injection experiments vessels have been demonstrated in cutis grafts on the third day. The newly built vessels arise by a budding of the capillaries in the fibrin layer, and the buds not infrequently extend directly into the vessels of the graft. Degenerative processes set in so that on the third or fourth day the epidermis with the upper rate layer of the skin are lost. The degenerative processes are pronounced at an early stage so that there is a vacuolization of the surface of the graft, hand in hand with the degenerative processes, regeneration goes on and it is usually so energetic that in six or eight days the entire transplant is covered with new epithelium. The degeneration extends beyond the epithelium to the cutis. The entire cutis is replaced by granulation tissue which in time shows a decrease in cells and blood-vessels and an increase in fibrous tissue. According to this, histologic examination established viability only, and this solely in the juxta-epithelial layer of the graft. The histologic changes in the whole thickness grafts do not differ materially from those occurring in the "Thiersch" grafts. The epithelium is slower to regenerate in full thickness grafts by a few days. Doctor Padgett's study of sections from our own cases does not show as much degeneration of surface epithelium nor of the cutis and corium. Sections taken from grafts which have good color show only a very superficial degenerative change in the outermost layer of epithelial cells, and when this layer is removed it leaves a skin which is a little more pink but otherwise normal in appearance, and microscopically the squamous cells appear a little oedematous and swollen. Evidently only the most superficial epithelial cells degenerate on good grafts. He does not believe that our sections show either as much degeneration of the squamous epithelial layer or of the cutis and corium as is usually described. The older grafts on inspection look rather normal in texture but a very pale tan with little suggestion of the normal pink of the surrounding skin. Histologic studies were made of approximately twenty grafts of this series varying from eight days to two years after implantation. The most noticeable change that occurs in the microscopic anatomy of an old full thickness graft is a smoothing of the surface best appreciated when a section of the graft is compared with a section taken from the site that furnished the graft. The papillary layer of the epithelium appears to be about normal except that it follows the flat contour of the surface. Elastic tissue appears to be present in about normal quantity. Fig. 21c, is the abdominal skin taken from alongside of the scar which resulted from removing the graft shown in Fig. (b). Note the surface irregularities. Fig. (b) shows a section of the graft twenty-two months after it was implanted in the forehead, where it "took" without any hesitation or any evident loss of epithelium. In Fig. (a) the papillary layer is brought out with more contrast. This is a section from a graft on the forehead of a six-year old boy done eight months previously, which has the same general appearance as the graft b. Note the hair follicle and gland remnant and the same absence of the normal surface irregularities that is to be observed in b.

TABLE I.
In Twelve Cases in This Series, 50 Per cent. or More of the Surface Area was Lost. The Table Below Gives Details of These Twelve Cases.

Source, location and reason for graft—Age of patient	Apparent cause and circumstances of loss	Remarks	Size of graft in sq. inch	Per cent. of graft lost	Final disposition and results
Abdomen to forehead to replace delayed flap in two month old infant	Graft came off at first dressing with no evidence of ever having adhered. Infection of bed due to contamination at operation and low resistance	After first of a series of operations for oblique facial cleft, child had diphtheria in affected eye; later pus infection of the deformed lacrimal sac which was removed. Of necessity the operation was resumed several weeks later. The conjunctiva became infected, the flap but partially adhered and an abscess developed in other side of neck.	3	100	Raw area allowed to granulate—it will contract enough to allow the scar area to be entirely replaced by the pedicle of the flap when the latter is returned to forehead.
Abdomen to forehead to replace delayed flap on young woman	Graft came off at first dressing with no evidence of ever having adhered. Infection of bed due to operative contamination and low resistance	Graft was applied two weeks after a severe tonsillitis in a series of operations that could not well be interrupted	6	100	Thiersch grafted granulating area later which "took" satisfactory and made fairly satisfactory final result.
Abdomen into floor of mouth through clean wound in neck in adult man	Most, if not all, of the graft was lost from maceration and infection due to lack of ventilation and impossibility to carry out routine after-treatment	This graft was sutured around a wax form at normal tension and buried under scar in the floor of mouth that remained after hemi-excision of tongue. The incision was made from the neck and was presumably clean. Esser technic.	3	100	Later, the tongue was again freed and an inlay. "Thiersch" graft applied. Final result 50 per cent. satisfactory.
Abdomen to forehead to replace delayed flap in fourteen year old girl	Infection of the graft which started in the epithelial surface after the graft had become adherent and before the original dressing was changed. Possibly due to operative contamination and low resistance	This child has been through a long series of operations to replace cheek, floor of orbit, lower eyelid and half of nose and upper lip lost from noma. She is a subject of low resistance and has reacted poorly after each operation and has had several infections during this period ranging from tonsillitis to hæmolytic streptococcus of the conjunctiva. An earlier first dressing might have saved much of this graft.	11	90	The granulations and remaining part of the derma were successfully covered with "Thiersch" grafts later. Fairly satisfactory final result. At another time she had a successful full thickness graft applied to the other side of forehead.

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Abdomen to cheek to replace burn scar on young man	Graft appeared perfect at first dressing, two days later when pressure dressing was left off to avoid saliva, flap became blue and ultimately died from blood stasis in spite of oft repeated scarification and citrate of soda packs	Where this pack rested on the body of the mandible some of the graft was preserved. It was the experience with this graft that suggested the necessity for the longer retention of the pressure dressing	12	70	Was regrafted, full thickness graft after slicing off granulations 36 days later. This second graft contained less than five square inches of skin
Abdomen to front of neck to release burn scar on fourteen year old girl	Graft became attached but on the day after operation certain areas appeared to be without elasticity; on cutting it was found the skin was dead. The slough was gradually thrown off (see Fig. 5). Necrosis apparently due to too firm pressure	This was one of the early cases in the development of the pressure dressing. The sponges were bandaged in so tight that the face was congested. The upper part of the larynx is particularly apt to kill the graft in this situation.	32	70	Regrafted at a later date when raw areas had scarred up.
Abdomen to cheek, nose, lower lid and upper lip to replace burn scar on two year old infant	Graft was compressed with a rubber bath sponge. Death seemed to be due to maceration caused by lack of ventilation and subsequent infection	This was one of the several grafts which were covered by a more or less impervious dressing all of which macerated to a greater or less extent	2	70	Area covered with a pedicle flap from forehead at a later operation.
Abdomen to lower eyelid, cheek and side of nose on seventeen year old retarded child due to a congenital infection	Graft adhered throughout but about half was lost apparently from superficial infection becoming active in the second week	In this case the vesicated areas were painted once a day with 1 per cent. silver nitrate in alcohol and it was thought this might possibly have helped to damage the epithelium. The graft contracted somewhat less than one-half its original area	3	50	Eyelid later restored with pedicle flap graft. The graft itself is a little glazed.

TABLE I.—Continued.
In Twelve Cases in This Series, 50 Per cent. or More of the Surface Area was Lost. The Table Below Gives Details of These Twelve Cases.

Source, location and reason for graft—Age of patient	Apparent cause and circumstances of loss	Remarks	Size of graft in sq. inch	Per cent. of graft lost	Final disposition and results
Abdomen to cheek to replace burn scar in a six year old boy	About one-half the graft became necrotic roughly corresponding in area to the body and ramus of jaw and zygoma but it was firmly attached at first dressing	Slough was finally thrown off—in places leaving granulations, in others a stippled base. The behaving and distribution of the dead skin seemed to indicate that too much pressure has been used. Note that in case No. 5 of this series where a very loose dressing was used that part of the graft overlying the bone was the only part saved	12	50	Scarred up and made a fairly good final result with all distortion relieved. The scars are red and rough but time will largely correct this.
Abdomen to front of neck to replace burn scar on nineteen year old girl	At first dressing, 9th day, a necrotic area was discovered over the upper part of the thyroid while the "take" lower down and in submental and submaxillary regions was perfect. Too great pressure and too much movement	On cutting into dead area two things were observed: first, that part of the dead graft in front of the pomun adami and thyrolyoid membrane was not adherent but surrounding this was a ring of dead graft that was adherent to the deeper tissue. Second, that a narrow bridge of live skin spanned the central part of this unattached and otherwise dead area.	7	50	Allowed to scar. Provision for loss had been planned for in the cutting and suturing the graft.
Abdomen to palm of little finger for burn scar in a young woman	Implanted partly on scar. Considerable superficial loss and contraction. Cause not very evident		1	50	Some flexion of the finger remained.
Abdomen to front of neck to release scar on six year old child	Dressed 5 days after operation much of graft macerated due to poor ventilation and infection	In this case the bandages over the marine sponge were daubed with vaseline to prevent possibility of vomit getting into sponge	22	50	Additional grafts added after healing.

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PERSONAL EXPERIENCE IN 21 CASES

By JOHN H. GIBBON, M.D.

OF PHILADELPHIA, PA.

IT HAS been twenty years since Matas presented a new and very rational method of treating accessible aneurisms, with a report of four cases, and in his last communication (*Résultats immédiats et éloignés de la Cure des Anévrismes—La Presse Médicale* No. 10, du 3 Février, 1923) he states that 350 endoaneurismorrhaphies have been reported, including 59 of his own. though this figure does not, of course, represent all the cases operated upon by this method, it seems, nevertheless, too small a number, particularly when one considers the great number of traumatic aneurisms which must have resulted from wounds of the blood-vessels in the late war. From personal observation and verbal reports I know that many ligations were done for the cure of these aneurisms where endoaneurismorrhaphy would have better served the purpose, in view of the fact that before the war enough cases had been reported to show that the Matas operation resulted in a lower mortality, a higher percentage of cures than the old ligation methods, and that it had practically eliminated gangrene, which under the most favorable circumstances followed the ligation of large arterial trunks in a certain percentage of cases. Sencert, of Nancy, in his book on "Wounds of Vessels" (University of London Press, Ltd., 1918) recommends extirpation, rather than ligation, in traumatic aneurism, and it seems to have been the method preferred by most French surgeons during the war. He says that gangrene is less frequent after extirpation than after ligation. In 93 cases of extirpation, which he collected from French and foreign literature during the war, gangrene followed in nine cases. In the British Service, ligation was the operation of choice. The Germans practiced suture of the injured vessel rather than ligation more extensively than the Allies, and they also utilized the intrasaccular ligation (the passing of a suture through the sac wall and about the artery) in aneurisms, where the restorative operation of Matas could not be done. Matas (Keen's Surgery, Supplementary Volume, 1921) says they used the restorative operation in about 50 per cent. of the saccular aneurisms. Most of the German surgeons gave up the extirpation of the sac in favor of the above-mentioned methods. It is impossible here to discuss in more detail the wide difference of opinion held by surgeons of the different countries in regard to the treatment of traumatic aneurisms, but the whole question, including the immediate treatment of wounds of the vessels, is thoroughly discussed by Matas in Keen's Supplementary Volume, published in 1921. I am convinced that the principles laid down by him are applicable to trau-

* Read before the American Surgical Association, April 18, 1924.

matic, as well as syphilitic, aneurisms, and it is to be regretted that more endoaneurismorrhaphies were not done during the war.

These observations have caused me to feel that an additional report of my personal experience may be timely and might prove the means of stimulating others to deal with aneurisms from within the sac and abandon ligation, which, though easier to do, carries with it a higher mortality and a smaller chance of cure.

I reported my first experience with the Matas operation in 1904 (*American Medicine*, August, 1905), and my second in 1907 (*ANNALS OF SURGERY*, September, 1907), and in 1912 I presented a summary of my experience in eight cases (*Jour. A. M. A.*, July 27, 1912). Since the publication of this paper I have operated upon 13 additional cases, bringing the total up to 21 cases. It might be added that no ligations for the cure of aneurisms have been done during the past twenty years, except for hemorrhage and except in aneurism of small vessels, such as the temporal and radial. I have also done one successful invagination operation on a small traumatic aneurism of the common carotid.

Of the total of 21 Matas operations, I would like to exclude from the present discussion one case of aneurism of the abdominal aorta, already reported, and one of the splenic artery, and consider only the remaining 19, all of which had to do with what are generally considered accessible aneurisms. Of these 19, there were 6 popliteal, 10 femoral, 2 femoral and external iliac, and 1 brachial. Six were traumatic and 3 of these were arteriovenous.

Deaths.—There were three deaths following operation; one was an anæsthetic death just at the conclusion of the operation; one occurred fifteen days after operation and twenty-four hours after a ligation of the femoral artery for secondary hemorrhage from the site of an obliterated popliteal aneurism. The patient was in good condition following ligation and died very suddenly the next day; the autopsy showed a vegetative endocarditis and splenic and renal infarction. The third death was in an extremely ill luetic negress with a femoral aneurism. The operation was done under local anæsthesia because of the patient's very grave cardiac condition. One week after the operation she had a hemorrhage from the site of operation, which was controlled by re-opening and re-suturing. She died suddenly the next day without any more bleeding or any symptoms indicating impending death. The autopsy findings in the case history, No. XV, I think show several sufficient reasons for her death.

I probably ought to say that one of my early cases of popliteal endoaneurismorrhaphy died of uræmia two months after operation, when his wound was healed. This man, a luetic, had chronic Bright's disease at the time of operation and local anæsthesia was employed. Therefore, it is not likely that the operation hastened his death.

In reviewing these deaths I do not think, with the exception of the second, that they can be attributed directly to the operation, or that any different

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results would have followed ligation. Two of the three patients had far advanced syphilis, lesions of the heart, aorta and viscera.

Hemorrhage.—In addition to the cases above mentioned, second hemorrhage occurred in two others, both traumatic femoral aneurisms. In one the bleeding occurred two weeks after operation, when the wound was well healed. It was controlled by re-suturing, but recurred four days later and a ligation of the femoral was done. The patient made a good recovery. In the second case, an enormous arteriovenous aneurism, bleeding occurred three weeks after operation, due to late infection, which I am sure resulted from the injudicious insertion of a soft rubber drain two weeks after operation because of a superficial collection of serum. Re-suture was done in this case also, but bleeding recurred and ligation of the femoral was done. This patient made an excellent recovery.

It will be noted that the bleeding in all these cases occurred from one to three weeks after operation. I think that secondary ligation two or three weeks after operation carries with it practically no danger of gangrene, as the collateral circulation is by this time well established.

Gangrene, Amputation and Secondary Aneurism.—There has been no gangrene and no amputation in any of these cases, including the fatal ones, and in this connection I would call attention to the fact that ten were aneurisms of the femoral and two of the femoral and external iliac. There has been no secondary aneurism. These results should be compared with 10 per cent. of gangrene in the 93 cases of extirpation reported by Sencert.

Results.—The 16 cases which survived operation have nearly all been traced, as shown by the case reports, and none have had any recurrence or any circulatory disturbance.

Technic.—It must be apparent that the treatment of aneurisms, resulting from disease of the blood-vessels, is different from that of those caused by direct injury of the vessel. In the case of the diseased vessel, the patients are practically all syphilitics, have more or less advanced disease of the heart and aorta, and often have liver and kidney lesions. In these cases far better results will be obtained if operation is preceded by an intensive anti-syphilitic treatment, including large doses of the iodides. The pain and the growth of the aneurism can be fairly well controlled by complete rest in bed and the constant application of an ice bag over the aneurism. It has been our rule to keep up the use of mercury and iodides after the operation. Some of our cases have easily taken 200 to 300 grains of potassium iodid a day. The improvement which takes place during this preliminary treatment has been quite remarkable in a few cases and it certainly has reduced the operative risks. In these cases, too, I would urge that the control of the circulation should only be made by digital compression. Temporary ligatures or rubber-covered artery clamps for the control of the vessel above the aneurism are likely to so injure it as to cause the subsequent development of an aneurism at the site where they have been applied. Such cases have been reported, just as they have after permanent ligation of the artery for the

cure of aneurism. For this reason, too, the tourniquet has not been used in our recent cases, although with it the risk of damage to the vessel is not so great. Digital compression of the vessel by an intelligent assistant is quite reliable, has only to be kept up for the few minutes it takes to empty the sac and to find and close the large openings into it. In the high femoral and the femoro-iliac aneurisms, the abdomen has been opened and the common iliac compressed by an assistant. These precautions are not necessary in the traumatic aneurisms, but even in these cases I think the temporary ligature should be avoided, though the tourniquet or rubber-covered clamps may be employed. Elevation of the extremity for a few minutes before the sac is laid open will do a good deal to conserve blood. In none of the cases here reported has the amount of blood lost at the operation been sufficient to affect the patient's general condition.

In all the aneurisms, due to disease of the vessel, I have done the obliterative operation. In most of the traumatic aneurisms and in the three arteriovenous aneurisms, the restorative type was done. I have not done the reconstructive operation and I have doubted its applicability, except in rare instances of traumatic aneurism, where a large part of the vessel wall is normal. In two cases of arteriovenous fistula, one of the brachial and one of the femoral vessels, the opening in the artery was closed, the vein ligated and a portion of its wall used to reinforce the closure of the artery.

I have come to the conclusion that catgut is the best material to use for closing the openings into the sac and for its obliteration, although I used linén thread for the deeper sutures in my earlier cases.

I have never used the mattress sutures through the skin to aid in obliteration of the sac, as was suggested by Matas in his original paper, because I thought that a suture passing through the skin and into the sac might be the means of causing infection.

Infection is a serious complication and may readily lead to secondary hemorrhage. This was certainly true in one of our cases, an enormous arteriovenous aneurism of the femoral vessels. One of the most important measures to take in order to avoid infection is complete hæmostasis within the sac and its complete obliteration. Pockets, where blood and serum accumulate, are dangerous foci of infection. Another source of infection is any kind of a drain, even the subcutaneous type. In order to prevent any subcutaneous accumulation of serum, it is better to leave considerable space between the skin suture than to use a drain, even for twenty-four or forty-eight hours. If any superficial infection should occur, the skin sutures should be promptly removed and no drain used. In the syphilitic cases I formally used a superficial drain, but considerable experience in war wounds has caused me to abandon the practice, as it is more apt to cause, than prevent, infection.

In arteriovenous fistula the artery and vein are always densely adherent for a considerable distance above and below the point of communication and their separation is tedious and difficult. In these cases it seems better to ligate the vein below and above the opening, without attempting separation from the

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artery, then to open the vein, with the arterial circulation controlled, and suture the opening into the artery. The vein wall between the ligation can then be used to reinforce the arterial closure. In one of my cases a large tributary vein opened into the involved vein between the ligatures and, should this occur, the tributary vein should be ligated beyond the main vein.

In the true arteriovenous aneurism it is unnecessary, I think in most cases, to dissect out the vessels above the aneurism. A tourniquet should be applied, the sac opened and the necessary occlusion done from within the sac.

I am inclined to believe after this review of my personal experience that the Matas operation is indicated in all accessible aneurisms, and that it should supplant ligation, because its dangers are less and permanent cure is more assured.

The following is a brief synopsis of our 21 cases. The first eight cases were reported in more detail in 1912:

CASE I.—Negro, male, aged thirty-one years. Pennsylvania Hospital, operation September 29, 1904. Syphilitic. Popliteal aneurism. Esmarch constrictor. Obliterative operation. No drain. Superficial infection. Eight years later patient was perfectly well.

CASE II.—Physician, aged fifty-seven years. Bryn Mawr Hospital, operation November 24, 1906. Syphilitic. Popliteal aneurism and advanced Bright's disease. Local anæsthesia and a little ether. Esmarch constrictor. Obliterative operation. Complete obliteration impossible; packing used. Wound healed by granulation. Patient died two months after operation from uræmia.

CASE III.—Negro, male, aged thirty-eight years. Pennsylvania Hospital, operation November 27, 1907. Large femoral aneurism. Probably not syphilitic. Digital compression of femoral, after exposure. Obliterative operation. Superficial drain. Slight infection. Discharged with healed wound January 4, 1908. Letter received five years later reported patient perfectly well.

CASE IV.—White, male, aged forty-four years. Jefferson Hospital, operation December 7, 1907. Large traumatic femoral aneurism. Esmarch constrictor. Obliterative operation. Patient died three years later from tuberculosis without any further trouble from the aneurism.

CASE V.—White, male, aged forty-five years. Jefferson Hospital, operation September 13, 1908. Aneurism of abdominal aorta, complicated by anuria, which suggested an aneurism of the renal artery. Symptoms suggestive of rupture on day previous to operation. Aorta controlled by rubber catheter and obliterative operation done. Patient died on the table.

CASE VI.—White, male, aged forty-six years. Pennsylvania Hospital, operation January 11, 1911. Popliteal aneurism. Esmarch constrictor. Obliterative operation. Superficial drain. Slight discharge from wound. Quite well eighteen months after operation.

CASE VII.—White, male, aged thirty-six years. Jefferson Hospital, operation July 12, 1911. Aneurism of femoral and external iliac (syphilitic). Abdomen opened and common iliac controlled by digital compression. Obliterative operation. Patient examined eight years after operation; excellent result; no symptoms.

CASE VIII.—Negro, male, aged thirty-six years. Jefferson Hospital, operation June 1, 1912. Popliteal aneurism (syphilitic). Esmarch constrictor. Obliterative operation. Anæsthetic death, as skin sutures were being introduced. Autopsy negative except aortic atheroma.

CASE IX.—Negro, male, aged thirty-two years. Pennsylvania Hospital, operation November 8, 1916. Femoral aneurism (syphilitic). Abdomen opened; digital compression.

sion of external iliac. Obliterative operation. Superficial infection. Discharged January 11, 1917; wounds healed.

CASE X.—White, male, aged twenty-six years. Jefferson Hospital, operation January 6, 1917. Popliteal aneurism (syphilitic). Confined to bed for six months. Digital compression of femoral without exposure. Local anæsthesia and a little ether. Obliterative operation. Secondary hemorrhage. Ligation of femoral under local anæsthesia two weeks after operation. Died suddenly next day. Autopsy findings: hypertrophy and dilatation of heart; fatty degeneration; acute vegetative endocarditis; splenic and renal infarction; red atrophy and fatty infiltration of liver and atheroma of aorta.

CASE XI.—White, male, aged eleven years. Jefferson Hospital, operation April 3, 1917. Traumatic femoral aneurism; three years' duration; gunshot wound. Digital compression of femoral without exposure. Restorative operation. Two weeks after operation with wound healed without infection bleeding began. Re-suture and transfusion. Bleeding began four days later and femoral ligated under local anæsthesia. Discharged with wound healed and pulsation in posterior tibial May 24, 1917. April 28, 1924, letter reports patient perfectly well; "cannot tell one leg from the other," and plays football.

CASE XII.—White, male, aged twenty-six years. U. S. Base Hospital No. 19, London, November, 1918. Traumatic femoral aneurism. Shrapnel. Restorative operation. Healed without infection. Evacuated to United States. Letter received April 19, 1924, reports no further trouble from aneurism.

CASE XIII.—White, male, aged twenty-six years. Pennsylvania Hospital, operation November 20, 1920. Arteriovenous aneurism of brachial vessels. Machine-gun bullet two years previous. Vein ligated above and below. Artery controlled by rubber-covered clamp compression. Restorative operation with reinforcement with section of vein. Discharged with wound healed. Unable to trace.

CASE XIV.—Negro, male, aged forty-seven years. Pennsylvania Hospital, operation November 30, 1921. Popliteal aneurism (syphilitic). Esmarch constrictor. Obliterative operation. Examined two years later; no further trouble from aneurism, but has cardiovascular disease.

CASE XV.—Negress, aged twenty-three years. Pennsylvania Hospital, operation December 21, 1921. Femoral aneurism (syphilitic). Acute endocarditis; fever; delirium; symptoms of splenic infarction. Improvement under anti-syphilitic treatment. Very bad operative risk. Local anæsthesia. External iliac exposed. Digital compression. Obliterative operation. Bleeding seven days later. Re-suture under gas anæsthesia; no more bleeding. Died suddenly next day, when apparently in good condition. Autopsy findings: acute and chronic endocarditis and aortitis; hypertrophy and dilatation of left ventricle; infarction of spleen and kidneys; atrophic cirrhosis of liver and vesicular emphysema of lungs.

CASE XVI.—White, male, aged twenty-seven years. Pennsylvania Hospital, operation September 27, 1922. Arteriovenous fistula of femoral vessels; gunshot wound twenty-six days previous. Esmarch constrictor. Restorative operation. Vein ligated and portion used to reinforce closure of artery. Prompt healing. Examined and found in good condition some weeks after discharge, but unable to trace since.

CASE XVII.—White, male, aged thirty-five years. Jefferson Hospital, operation October 16, 1922. Enormous arteriovenous aneurism of femoral vessels. Stab wound, with scissors, four months previous. Esmarch constrictor. Restorative operation done on both vessels. Wound healed primarily. Two weeks later some serum evacuated and, without instruction, a drain inserted. Later infection and bleeding. Sac re-opened and bleeding vein sutured. No bleeding from sites of previous suture. Wound packed open because of infection. Transfusion. Bleeding occurred at the end of week and again controlled by suture within the contracted sac. Another hemorrhage a few days later. Ligation of superficial femoral. Made good recovery and is now perfectly well.

CASE XVIII.—Negro, male, aged thirty-five years. Pennsylvania Hospital, operation November 14, 1922. Popliteal aneurism (syphilitic). Digital compression of femoral

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without exposure. Obliterative operation. Returned to work in post office two months after operation and was without symptoms and still working, November 14, 1923, one year after operation.

CASE XIX.—Negro, male, aged fifty-one years. Pennsylvania Hospital, operation January 9, 1923. Aneurism of femoral and external iliac (syphilitic). Extended up to within two inches of umbilicus. Abdomen opened and abdominal aorta controlled by digital compression. Obliterative operation. Discharged March 3, 1923, with wound completely healed. April 21, 1924, has had no further trouble.

CASE XX.—White, male, aged fifty-four years. Jefferson Hospital, operation March 5, 1923. Aneurism of splenic artery. Not(?) syphilitic. Pre-operative diagnosis, upper abdominal tumor, probably retroperitoneal. Mass found attached to tail of pancreas, which was thought to be a cyst. No pulsation. During separation, rupture occurred with profuse bleeding and evacuation of clots; finger introduced into sac; discovered opening of vessel and bleeding was easily controlled while quantities of clot were evacuated. The arterial opening into the sac was closed by suture and the sac obliterated. Patient was in good condition the next day, but then developed a broncho-pneumonia and died on the third day, with a high temperature. He had no symptoms of bleeding and no abdominal symptoms. Autopsy findings: aneurism of splenic artery; no blood in abdomen and no peritonitis; marked fibrosis of aorta; sclerosis and dilatation of left common iliac; acute suppurative bronchitis and early broncho-pneumonia. Wassermann from heart blood negative.

CASE XXI.—Negro, male, aged forty-five years. Jefferson Hospital, operation April 23, 1923. Femoral aneurism (syphilitic). Abdomen opened and common iliac controlled by digital compression. Obliterative operation. Patient examined in November, 1923, and there was no evidence of recurrence and he had no pain in leg.

CIRSOID ANEURISM OF THE SCALP*

WITH THE REPORT OF AN ADVANCED CASE†

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FROM THE CLINIC OF DR. HARVEY CUSHING, PETER BENT BRIGHAM HOSPITAL, BOSTON, MASS.

CONGENITAL telangiectases, vascular nevi, or angiomas, which occur so commonly on the face and scalp, may be the starting point of disfiguring aneurismal tumors. When the contributing arteries and the outgoing veins succeed in forming anastomoses through the cavernous bed of the nevus, the lesion becomes nothing more than a diffuse arteriovenous fistula. Such is the probable etiology of most so-called cirroid aneurisms in which the intermediary incidence of trauma in many cases seems definitely established.

In its mechanical effects, therefore, a cirroid aneurism resembles an arteriovenous fistula, with the difference that in the latter condition the communication is usually (though not invariably) single, whereas in the true cirroid the communications are multiple, and take place through the vascular meshes of the tumor.

The condition must have been recognized from the earliest times in view of its striking characteristics, and it would be an interesting study to trace in detail the early records of the lesion;‡ it is not at all improbable that some ancient example may have given rise to the legend of the serpents in the hair of Medusa which Perseus cured by radical though unprofessional measures.

It would appear that the term *anévrisme cirsoïde* (varix-like) was first used by Brescht in 1833, long after William Hunter's description of "aneurism by anastomosis." Though other designations were introduced, as *aneurysma serpentinum* by Cruveilhier, the term "cirroid," accepted by Verneuil and by A. Robert in 1851, as well as by Ch. Rubin in his excellent description of the erectile tumors three years later, has subsequently come to be the one generally employed in French and English literature.

In the German literature, however, the cases for the most part must be sought under other titles, due largely to the influence of Virchow, who proposed the term *aneurysma racemosum* or *ranken aneurysma*. Moreover, fully cognizant of the fact that a congenital angioma was often the starting point of these lesions, he designated them as *rankenangiom* or *angioma racemosum arteriale*.

* Read before the American Surgical Association, April 18, 1924.

† To Dr. Harvey Cushing the writer is indebted for permission to publish this case. Obligations are also due to Mr. K. E. Appel, of the Harvard Medical School, for his aid in reviewing the literature.

‡ For anyone so disposed, the section in Rudolf Virchow's classical treatise on tumors (*Die Krankhaften Geschwülste*, vol. iii, p. 471 *et seq.*) would make a proper point of departure.

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Undoubtedly the cases in the early literature, many of which are cited by Virchow, comprise lesions of various kinds, not all of them in association with primary angiomas; for it is quite probable that arteriovenous fistulæ (more especially those with single or multiple communications involving the vessels of the face and neck) may arise through some faulty vascular development, which may leave one or more arteriovenous communications without the intermediation of a cavernous angioma.¶

From this preamble it may be gathered that there are several varieties of so-called cirroid aneurism arising in various parts of the body which deserve clinical and pathological differentiation. The present communication, however, will be limited solely to a brief consideration of the anastomosing aneurisms of one type and in one situation: namely, those which affect the scalp and which arise through the intermediation of a preëxisting vascular abnormality of a congenital, angiomatous nature.

In any outspoken example of this condition, the clinical picture is such a startling one that the case is likely to be reported. The extensive literature on the subject shows that these cirroid aneurisms more often occur on the face and head, whether for the reason that congenital vascular nevi are more common there or because the head is more exposed to the kind of trauma likely to provoke an aneurismal change in the preëxisting lesion is not apparent. Nevertheless, cirroid aneurisms of the advanced type observed in the patient whose case-history follows are not common. It is the first example of the condition in the *circa* 35,000 admissions to the Brigham Hospital.

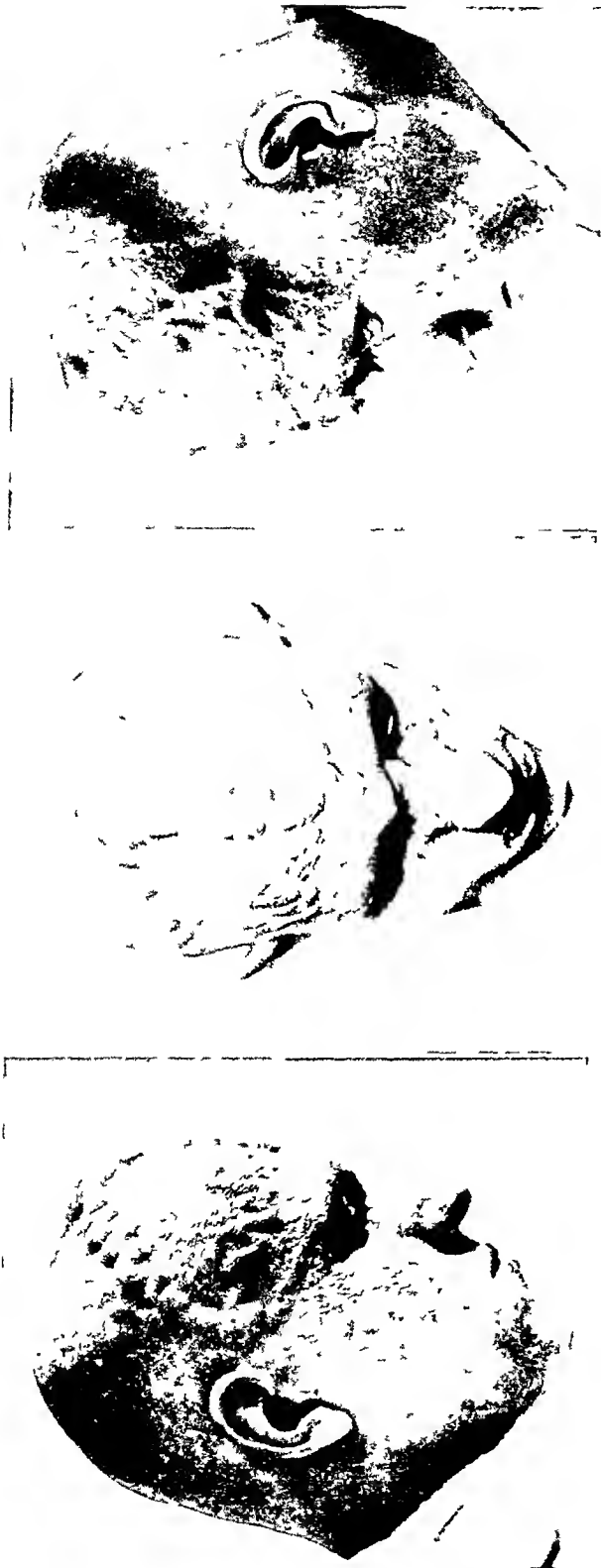
P. B. B. H. Surgical No. 17539. John A., an Italian wool-worker, aged twenty-two, entered the medical service of the Brigham Hospital, October 9, 1922 because of a chronic cough, "swellings" on his forehead, and headaches. Though suspected of having incipient pulmonary tuberculosis, he was soon transferred to the surgical service for treatment of his aneurism.

In 1918, while serving in the Italian Army, he had received some minor shrapnel wounds of the scalp, and was subsequently taken prisoner. His wounds which were confined to the occipital region, required no especial care, and though none of them appear to have affected the central region of the aneurism, he states that the top of his head was badly contused at the time.

To this trauma, he naturally ascribes the present condition, for soon afterward, he first noticed the pulsating swelling under the frontal hair margin, which has gradually increased in size. He soon began to be conscious of a roaring sound in his ears and at present this bruit and the startling appearance of the huge vein in his forehead constitute his chief annoyances.

Examination showed a vigorous, alert young Italian who, aside from a chronic bronchitis of doubtful origin, appeared to be in good general physical condition. The outstanding feature of his case lay in the lesion thus described by Doctor Cushing in a

¶ It is quite possible that the recent case reported by F. L. Meleney (Surg., Gynec. and Obst., 1923, vol. xxxvi, p. 547) was of this type. The patient had a small arteriovenous aneurism under the chin. Doctor Meleney has supplied "a complete bibliography of the literature as given in the *Index Medicus* since 1879." This bibliography, however, is confined almost entirely to articles which have appeared under the title of "cirroid aneurisms" whereas almost an equal number of important articles, chiefly in the German literature and otherwise entitled, do not appear in his list.



FIGS 1, 2 and 3 — Condition before operation, October 18, 1922.

note dictated shortly before the operation, when the accompanying photographs were taken (Figs. 1, 2 and 3):

"Before this man's head was shaved, there was discernible through the hair a faintly reddish, soft, warm, pulsating tumor measuring 6 by 6 cm, slightly elevated above the surface of the rest of the scalp and situated in the midline about at the coronal suture. Radiating from this tumor in all directions but chiefly laterally and anteriorly are huge, tortuous vessels, the appearance of which naturally suggests the snakes in the head of Medusa. Through the hair, the slightly prominent central area, owing to its discoloration and increased heat, gave the impression of an inflammatory process on the verge of ulceration. After shaving, however, it becomes evident that the central lesion is a reddish nevus, doubtless congenital, of the port-wine-mark variety which overlies a cavernous angioma.

"The enlarged and tortuous vessels which radiate from the lesion are chiefly confined to the anterior half of the scalp. The three main outstanding channels are evidently veins, though they show visible pulsation and have a palpable thrill. The largest of these is a broad vessel measuring nearly 4 cm. at its widest point which passes downward toward the root of the nose. There it bifurcates and extends on each side as far as the alæ. Another large tortuous vein passes off from the right side of the central swelling and extends down toward the anterior part of the ear, where, like the aforementioned vessel, it becomes gradually narrower and finally disappears. There are

similar vessels on the left side of the scalp, though less marked than those described.

"These vessels, which are obviously huge pulsating venous channels, are easily distinguished from the arteries, which, however, are likewise unduly prominent and

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unusually tortuous, and which can be palpated all the way from their points of appearance on the scalp directly into tumor. This is particularly true of the greatly dilated anterior branch of the right temporal, which can be traced directly into the site of the main central lesion; the same is true of the left temporal as well as the supraorbital arteries. The suboccipital arteries are likewise full and large, and pulsating vessels can be felt over the scalp in the occipital region as well as in the anterior areas where, however, they are particularly pronounced.

"While the patient is sitting up, it is possible to empty the large vessels by pressing upon them near their point of emergence from the main central lesion, proving that they are efferent veins. Moreover, they are visibly pulsating, and there can be no question, therefore, but that arterial circulation through some form of communication is thrown directly into them. The central tumor or swelling is pulsating and apparently contains a large lake of blood. Its tension varies considerably, depending upon the position of the patient, but even when he is sitting up and when all of the arteries possible are compressed, it still remains tense and pulsating.

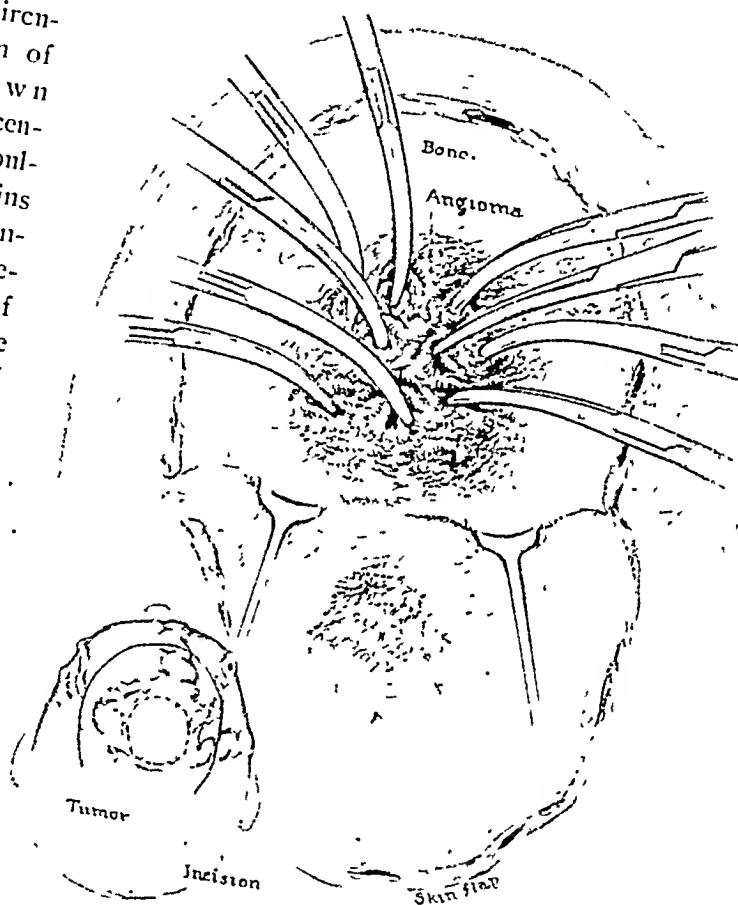


FIG. 4.—Operative sketch indicating procedure which was followed after extensive carotid ligation.

"Pretty much over the entire scalp is heard an astounding bruit, which is audible to the patient and which is precisely like that accompanying an arterial venous aneurism. It is curious, however, that this bruit though heard all over the head is louder at the lower margins of the scalp, particularly in the temporal region and over the glabella than it is directly over the central pulsating tumor itself, where, as a matter of fact, the bruit is scarcely to be heard.

"The X-ray plates show greatly dilated spheno-parietal grooves, and it is quite probable that there is a dilatation of the meningeal vessels corresponding to that of the extracranial vessels. The meningeal artery consequently may participate in the process, and it is possible that the dilated meningeals may communicate with the longitudinal sinus, and thus with the extracranial pulsating mass which has been described. This seems the more probable in view of the fact that when a tourniquet is applied around the head shutting off the extracranial arterial supply there is an enormous increase in the size of the veins of the 'caput' which distend to such a degree that rupture seems impending. This observation makes it appear that a bilateral ligation of the external carotids will be a necessary preliminary step to the operation."

Doctor Cushing's operative note November 4, 1922, is in large part as follows:
"Ligation of each external carotid artery. Reflection of scalp, disclosing cavernous



FIGS. 5, 6 and 7—Condition February 2, 1923, three months after operation following radiotherapy.

angioma. Puckering of angioma by multiple sutures. Replacement and suture of scalp in layers.

"The external carotids were exposed, first on the right side where the vessel was immediately ligated then on the left, where a provisional ligature was thrown around the vessel and a bulldog clip applied so that the circulation might be reëstablished should a slough of the scalp be threatened.

"As shown in the accompanying sketch (Fig. 4), a horseshoe-shaped incision with its base posteriorly was then made around the central pulsating angiomatous mass. By the usual method of finger compression of the scalp, this incision was carried down through the galea and the huge vessels at each side were caught by clamps. Naturally there was no arterial bleeding but the large veins remained as full apparently as before the carotid ligations. On reflecting the flap of the scalp in the subaponeurotic layer, the chief angiomatous tumor was exposed. It seemed to lie more or less within its own pericranial capsule from which the scalp could be dissected away without great difficulty. Fortunately, this central lesion had a great deal of fibrous tissue so that it could be caught by a series of heavy curved clamps (cf. sketch) as the scalp was peeled away from it. Subsequently a multitude of through-and-through silk sutures were taken where the tumor had been gathered up in these clamps: thus the growth was thoroughly 'puckered' in the hope that thrombosis might be encouraged.

"There was no special difficulty in this procedure and the hæmostasis was fairly complete. The scalp was then replaced and closed carefully in layers as usual without any special attention being paid to the individual dilated vascular channels. The bulldog

CIRSOID ANEURISM OF THE SCALP

clip was then removed from the left external carotid, but the arteries in the scalp promptly filled and it was evident that there would be some bleeding. The provisional ligature therefore was tied before closing the wound in the neck."

The circulation in the scalp seemed perfectly good when the usual dressing was applied. However, a very slight superficial slough of the flap margins occurred as the broad scars in the accompanying photographs (Figs. 5, 6 and 7) make evident. The central lesion was subsequently radiated to encourage endothelial destruction and thrombosis.

As is evident from this description, the operation consisted in an attempt to interrupt the vascular channels by an incision encircling the central lesion in the hope of producing thromboses which would cure the fistulous character of the lesion without removing the benign angioma itself. The operation was less formidable than anticipated and it is possible that the cavernous portion of the angioma underlying the galea might have been subsequently removed. This would have meant carrying the dissection down to the skull and removing the tumor together with the pericranium, but, as stated in Doctor Cushing's note, it was assumed that the lesion had vascular connections through the skull with the sinus longitudinalis and was possibly fed by the meningeal vessels. The outcome of the operation showed that this was apparently a mistaken idea: and though the central angioma therefore might have been removed, it is an innocent vascular anomaly in which the possible acquirement of further aneurismal characteristics seems remote. The lesion remains quiescent at the present writing, a year after the operation.

Comment.—As stated in the introductory paragraphs, it is the purpose of this paper merely to put on record another outspoken example of cirsoid aneurism of the scalp with no pretense of covering the full literature of the subject. A large number of these cases have been recorded and many of them have been successfully treated either with amelioration or with cure by a great variety of surgical procedures—by single or bilateral carotid ligations; by multiple circumferential ligations; by attempts to obliterate the lesion with the galvanocautery; by acupressure; by the injection of thrombosing or scar-forming substances; or indeed by extirpation.

Of the many remarkable examples in the literature, possibly the case best known to surgeons was that reported by H. Müller¹ in 1891 from the clinic of Paul Bruns. For his paper was accompanied by a drawing (Fig. 8) which has passed down through several generations of texts and has consequently familiarized many with the appearances of the lesion on post-mortem dissection. As is so common, the patient had a red birth mark at the hair margin of his forehead which greatly increased in size and by his twentieth year had acquired the appearances shown in the dissection. Bruns first ligated the right external carotid and on attempting the same thing on the other side encountered severe bleeding and was compelled to ligate the left common carotid. Hemiplegia followed with a fatality and Ziegler made the studies which have given us this striking illustration of the lesion.

¹ Ein Fall von arteriellem Rankenangiom des Kopfes. Beitr. z. klin. Chir., 1891, vol. viii, pp. 70-91.

To be sure, many other examples occur in the German literature, the surgical aspects of which are chiefly emphasized, some of them representing very formidable conditions. An excellent résumé of the subject up to 1883 was given by Hermann Kummell.² One of the better known cases subsequently reported is that by Paul Clairmont³ in 1908, the lesion having been attacked in two stages without preliminary carotid ligation. Another outspoken case reported by Max Kepler⁴ was operated upon by Heineke in

1910: a huge cavernous cirroid of the parieto-occipital region, a very desperate and bloody procedure carried out in two stages with a subsequent skin-graft.

The French literature likewise contains a good many comparable examples and recently Noordenbos of Amsterdam has reported a case⁵ very similar to the one the subject of this report. At the age of twelve the patient had applied for removal of a small vascular tumor on his forehead, but operation was thought inadvisable. Twenty years later, because of its enormous increase in size and its tendency to bleed, inter-

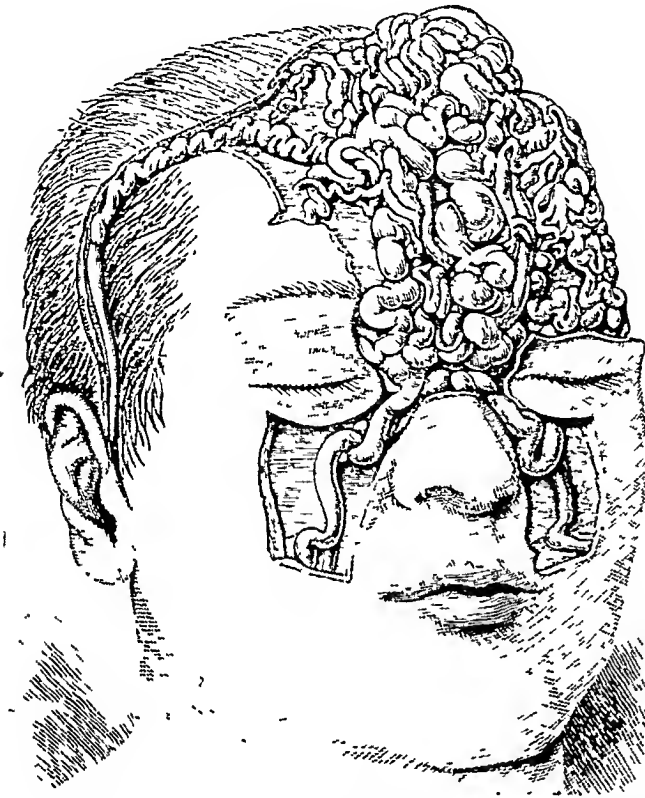


FIG 8 —Dissection of a plexiform angioma of the forehead.
(After H. Muller)

vention was imperative. At operation the external carotid and frontal arteries were ligated on both sides. Catgut sutures were then passed around each afferent vessel and tied over a small roll of gauze. The whole tumor mass was then excised down to the periosteum. Subsequent skin-graft resulted in complete recovery.

The question of an intracranial extension of the lesion which was feared in the case herein reported has arisen in the minds of a good many others and

² Zur Behandlung des Angioma arteriale racemosum. Arch. f. klin. Chir., 1883, vol. xxviii, pp. 194-213.

³ Zur Behandlung des Angioma arteriale racemosum. Arch. f. klin. Chir., 1908, vol. lxxxv, p. 549.

⁴ Zur Behandlung des Aneurysma arteriale racemosum Beitr. z. klin. Chir., 1912, vol. lxxviii, pp. 521-536.

⁵ W. Noordenbos and R. de Jong. Aneurysma arteriale racemosum van het Hoofd. Nederlandsch Tijdschrift voor Geneeskunde, 12 Oct., 1918, vol. ii, pp. 1224-1235.

CIRROID ANEURISM OF THE SCALP

has been thought probable in view of the fact that in a number of patients (*e.g.*, Clairmont's) epilepsy has supervened or else there have been definite evidences of mental deterioration. Indeed, the question was raised as long ago as by Guérin (1870) as to whether an extensive cirroid of the scalp could come into communication with the intracranial vessels and sinuses. It would appear, however, as was true of our patient, that there was no real ground for this apprehension and seemingly in all other cases disclosed no alteration in the skull or evidence of intracranial communication. There nevertheless have been reported a good many examples of aneurismal varices which have originated within the cranial chamber. This, however, is quite another subject.

Very little has been said in the foregoing paragraphs of the cases which have been published from American clinics—all of them, to be sure, very briefly recorded. The older medical literature antedating the great medical indices, if thoroughly perused, would of course be found to contain the records of some of these surprising lesions. Attention may be drawn to two of these early reports at least. One of them was put on record in 1853 by Dr. R. D. Mussey,⁶ Professor of Operative Surgery in the Miami Medical College at Cincinnati, Ohio, who described his case under the caption of "Aneurismal Tumors upon the Ear Treated by Ligation of Both Carotids." He speaks of the lesion as being "like an aneurismal varix which had arisen in a congenital nevus."

Another example will be found in a volume published in 1867 by J. Mason Warren,⁷ then surgeon to the Massachusetts General Hospital. The case, similar to our own, was described as a so-called cirroid aneurism of the scalp arising from a congenital nevus starting about at the midline in the roots of the hair "which gave him a very formidable aspect"; and Doctor Warren goes on at length to tell of the many and varied procedures which were carried out by ligatures thrown over needles, followed by the applications of caustic potash repeated between twenty and thirty times to destroy the central lesion.

There are doubtless other similar cases buried in the early American literature. The following list, which may be incomplete, will nevertheless serve to assemble most of the cirroid aneurisms of the scalp which since 1887 have been put on record in this country.

- (1) T. M. MARKOE of New York (*Phila. Med. News*, 1887, vol. 1, p. 270). A brief report of a case following trauma, with ligation of both external carotids and probable improvement.
- (2) HERMAN MYNTER of Buffalo (*ANNALS OF SURGERY*, 1890, vol. xi, p. 93). A case with ligation of one external carotid followed by circumferential ligation of vessels. Improvement but no late report.
- (3) WILLY MEYER of New York (*N. Y. Med. J.*, 1892, vol. lvi, p. 214). A very brief report possibly of an arteriovenous fistula rather than a true cirroid aneurism involving

⁶ *Am. J. Med. Sc.*, 1853, vol. xxvi, p. 333.

⁷ *Surgical Observations with Cases and Operations*. Ticknor and Fields, Boston, 1867. Case cclxii, p. 451.

ing the temporal region. Primary ligation of external carotid with excision of aneurism. In the discussion, cases were mentioned by J. D. Bryant and Kammerer.

(4) WILLIAM D. HAMILTON of Columbus, Ohio (N. Y. Med. J., 1894, vol. lx, p. 550). Ligation of one common carotid. Improvement but no late report.

(5) W. S. FORBES of Philadelphia (Phila. Med. News, 1895, vol. xlv, p. 663). A case almost exactly like our own, with central pulsating tumor following trauma. Treatment, acupuncture of entering vessels and subsequent excision of central tumor. Recovery.

(6) WILLIAM B. COLEY of New York (ANNALS OF SURGERY, 1901, vol. xxxiv, p. 114). Unilateral case with involvement of right temporal region; not advanced. Ligation of right external carotid followed by direct attack on tumor. "Nearly one hundred ligatures were applied." Recovery, but result uncertain.

(7) CARL BECK of New York (ANNALS OF SURGERY, 1903, vol. xxxviii, p. 496). "Aggravated case" following trauma. Ligation of temporal and other arteries with extirpation of tumor. Profuse hemorrhage. Recovery.

(8) RUDOLPH MATAS of New Orleans (New Orleans Med. and Surg. J., 1908-9, vol. lxi, p. 469). Brief report at a society meeting probably a true post-traumatic arteriovenous fistula, not a cirroid case, though so reported. A bilateral, pulsating exophthalmos was present following fracture of the base of the skull. Ligation of both external carotids. Temporary relief with slowly progressing recurrence.

(9) E. S. JUDD of the Mayo Clinic (St. Paul Med. J., 1916, vol. xviii, p. 48). Perhaps the most extreme example of the condition on record. Ligation of both external carotids followed a week later by bilateral reflection of scalp and dissection of vessels. Probably complete cure.

ANEURISM OF THE INTERNAL MAMMARY ARTERY*

BY FRED W. RANKIN, M.D.

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THE internal mammary artery, coming off from the subclavian vessel opposite the thyroid axis, pursues an extrapleural course through the thorax to about the junction of the sixth rib with its costal cartilage, where it divides into two trunks; the musculo-phrenic and superior epigastric, the latter of which completes the anastomosis between the upper and lower sections of the body by joining with the ascending branch of the deep epigastric. The anatomical protection of the chest wall renders this vessel less liable to injury than the more superficial vessels of the extremities, and yet occasionally it is divided by a gunshot or stab wound, which in addition almost invariably injures some of the thoracic viscera. Following such an injury a false aneurism or pulsating hæmatoma is rarely seen. Weiting notes two cases of false aneurism of this vessel seen in chest injuries during the recent war. True aneurismal formation, however, is an exceptionally rare occurrence, as a search of the literature reveals only three cases of this nature. In each instance there was a failure of diagnosis; one case being mistaken for an aneurism of the innominate artery or arch of the aorta by one physician, but diagnosed and operated upon for an abscess of the chest wall by another. The other two cases were also operated upon with a mistaken diagnosis and all three terminated fatally. The case which stimulated my interest in this condition came to the Dispensary January 24, 1923, with a pulsating tumor the size of a hickory nut, which presented in the third interspace about one inch from the sternal border. A diagnosis of aneurism of the right internal mammary was made after considerable consultation, and the lesion treated by extirpation of the aneurismal sac which was followed by a prompt and rapid recovery. The case report is as follows:

D. O. Colored, female, age forty-one, married. Chief complaint.—Swelling on right side of chest; some sense of pain around heart.

Family History.—Father dead, tuberculosis, aged fifty. Mother dead, tuberculosis, aged forty-nine. Two brothers living and well; one dead, meningitis. Two sisters living and well; two sisters dead, tuberculosis. Two children living and well. Has had measles, mumps, whooping cough.

Past History.—Patient has been in good health until July, 1923. At sixteen years of age had typhoid fever with complete recovery. At twenty-one years of age she had small-pox. Has dull headaches occasionally which last for about two days. Patient complains that she gets blind when she stoops at times, and notes that headaches precede her menses. There is no alopecia.

Eyes.—Some disturbance of vision, has to wear glasses. *Ears:* Negative. *Nose:* Negative. *Mouth:* Has recently had all of her teeth pulled. *Neck:* Negative for thyroid enlargement.

* Read before the American Surgical Association, April 18, 1924.

There is no trachial tug. The glands in the posterior triangle of the neck are palpable, but small.

Cardio-respiratory.—Has some cough at times over four or five years; No dyspnoea. Patient thinks she has spit up some blood and had some night sweats, but physical findings and X-ray do not reveal evidences of pulmonary tuberculosis. She has lost thirty pounds



FIG. 1.—Photograph showing internal mammary aneurism projecting in third right interspace.

in weight since last July. Gastro-intestinal: Negative. Patient has been constipated for some years. Genito-urinary: Negative, except for some frequency of urination.

Venereal.—Patient had a yellowish vaginal discharge a few years ago, but this cleared up under treatment. She denies syphilis or other venereal disease.

Menstrual History.—Menses began at sixteen, but prior to that time she had bled vicariously through the nose several times. Up to three years ago her menstruation was regular, occurring once a month, and lasting three or four days. For the past three or four years her menses have been very irregular, occurring twice a

month and lasting for seven or eight days. She has some leucorrhœa which is odorless.

Marital History.—Has been married twenty-two years. Has had seven pregnancies; all labors difficult, usually lasting 24 hours or more. She has two healthy children, twenty-one and eighteen years of age respectively, and has had five miscarriages.

Present Illness.—In July of the present year, patient noticed a small pulsating tumor along the right side of the sternum. This tumor began to increase and has progressively and slowly enlarged since. About one month ago she noticed dull pain and tenderness in the entire upper portion of her chest anteriorly. She has had some vertigo occasionally. For the past week has had some dull aching pains in the precordial region. They seem to begin in the axillary line and advance to the sternum, being more marked under the left breast. She has lost thirty pounds in weight in the past seven years; her best weight being 140 pounds; her present weight 110.

ANEURISM OF INTERNAL MAMMARY ARTERY

Physical Examination.—The examination of the tumor mass shows a pulsating expansile tumor of the right anterior thoracic wall in the third interspace over which a distinct bruit and thrill can be made out. The tumor is about the size of a hickory nut and may be picked up between the fingers, apparently having no attachment to the chest wall. There is no difference in the radial pulse on either side, pulsating in the tumor is synchronous with the radial beat. The blood pressure on each side is 115/80. The skin over the tumor is movable and there is no evidence of inflammation.

Fluoroscopic examination of the chest shows a normal heart and aorta and shows nothing in the area occupied by the tumor.

Wassermann is positive—Four plus.

Urinalysis.—Specific gravity 1020, negative for albumin and sugar. Microscopic examination shows few pus cells and numerous epithelial cells. No casts.

Blood.—Hemoglobin 85 per cent. White blood cells, 7,500.

Operation.—Under ether anesthesia an extirpation of the tumor mass was made on January 24, 1923. A longitudinal incision parallel to and about one inch from the outer border of the sternum, and extending from just below the clavicle to a point about one



FIG. 2.—Gross specimen, anterior view showing the sac on the external chest wall, with the resected ribs and costal cartilage.

inch above and external to the ensiform, gave ample working exposure. The first step in the incision was to expose the mammary vessels in the first interspace in order to control any of the bleeding that might occur. These vessels, both artery and vein, were found to be dilated the artery being about the size of a normal superior thyroid and the veins correspondingly enlarged. By pressure over the vessels all pulsation in the tumor was stopped. Owing to the rich collateral circulation it was not felt that simple ligation would suffice. I tied the vessels here with catgut and then removed portions of the second, third, fourth, and fifth ribs for about one inch back of their junction with their costal cartilages and elevated this flap until it was possible to tie the superficial epigastric below the tumor. The corresponding intercostal vessels were ligated as they were approached. By blunt dissection I was able to free the pleura from under the sternum and to get a finger around the entire tumor mass. The costal cartilages were then excised close to the sternum and the aneurismal sac with the portion of the chest to be sacrificed was removed as one specimen. The sac was found to hold about an ounce of fluid and to emerge between the costal cartilage of the third and fourth ribs. There was no bone necrosis at costo-rib junction. The wound was closed without drainage.

The patient made an uninterrupted convalescence and was dismissed from the hospital on the tenth day.

Discussion.—The first case that I have been able to find in the literature was that of

Siekles, who reported in 1847 a case which he had seen eight years previously. This case presented a small tumor of the left chest wall which emerged between the third and fourth ribs and which was about the size of a common marble. By pressing the finger hard upon it he was able to make it disappear into the chest. From its expansile pulsation and the bruit a diagnosis of aneurism was made, but he felt that the aneurismal formation was in the aorta or innominate vessel. The patient subsequently went to another physician and a diagnosis of abscess was made and the tumor was lanced. The ensuing hemorrhage was controlled by pressure but recurred eleven days later with a fatal termination. The autopsy proved the case to be an aneurism of the internal mammary vessel and not of the

aorta. The autopsy also revealed that there was some absorption of the fourth rib and a portion of the sternum.

In 1896, Campos Huguency reported a case of a man fifty-four years of age who presented himself with a tumor of the right chest wall about the size of a walnut, about opposite the sternum in the third interspace. This had been diagnosed a sebaceous cyst and incised. The hemorrhage which had occurred was controlled by direct compression and tampons of hyperchloride of iron. Eleven days following this when seen by Huguency the tumor presented

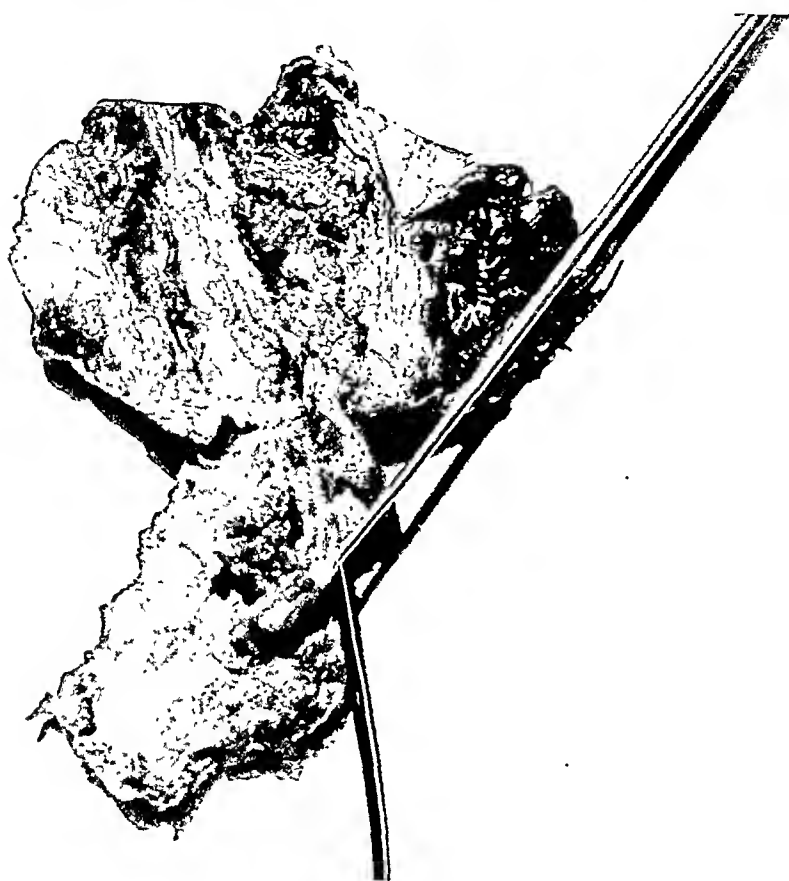


FIG. 3.—Posterior view of same specimen with probes in the mouth of the vessel.

a large ulcerating mass with gangrenous odor, without bruit or expansion; pulsations were synchronous with the radial, and the consistency of the tumor was that of a sac and fluctuant. Recognizing the condition he ligated the internal mammary vessel in the first interspace and abandoned extirpation of the tumor mass. The patient died sixteen days later of a recurrent hemorrhage. Autopsy revealed a true aneurism of the internal mammary vessel.

The case of Reynes published in 1909, was very similar to the two mentioned before. The difficulty of diagnosis is apparent from the notes he makes on the case, and despite considerable consultation he was unable to decide definitely between aneurism of the aorta, a cold abscess, or a pulsating empyema. Finally aneurism was excluded and the tumor mass opened followed by a severe hemorrhage.

Again this was controlled by pressure, which recurred three days later and the patient died.

ANEURISM OF INTERNAL MAMMARY ARTERY

The aneurismal sac was typical of this type of case the vessel having made a small opening into the tissues and then forming a false aneurism which extended along the ribs communicating with the artery by a narrow neck. On the interior of the thorax was a true aneurismal sac which he aptly describes as an aneurism like a button sewed on a shirt. The artery below the aneurism was obliterated.

It is evident from the observations of the men reporting these cases that a diagnosis is not always apparent, even after careful consideration, and because the röntgenological findings are not conclusive one is frequently confused by several possibilities. Obviously an expansile tumor in any portion of the body over the course of any blood-vessel should be suspected of being an aneurism. In this particular location where the most frequent aneurism is that of the arch of the aorta, the X-ray is of value in determining the size and position of the heart and great vessels of the thorax. In our case the fluoroscopic findings demonstrated that the heart was normal in size and position, and the aorta was normal; the area over the tumor mass showed no difference in density. A pulsating empyema or cold abscess over the ribs themselves would ordinarily be differentiated by the röntgenological findings. The sphygmograph should be a very material aid in deciding the diagnosis by giving the characteristic deformity of the radial pulse in the case of an aortic aneurism; also the anatomical level of the tumor in the third interspace should be sufficient to reject the hypothesis of aortic aneurism. Reynes points out a sign which he believes will enable one to make a diagnosis between an aortic aneurism and an aneurism of the internal mammary. I quote his article: "Aneurism of the internal mammary is of such rarity that one should stop and argue the possibilities of such a thing. If there is aneurism one would be more liable to think of the aorta. However, there are two signs against this diagnosis. First, aortic aneurism; the location of the tumor in the third interspace instead of the second, which indicates at least that the aneurism is very small. Second, the propagation of the systolic bruit is very harsh, especially at the level of the tumor. This bruit follows very nearly the direction of the third and fourth ribs in the axilla and absolutely does not ascend toward the clavicle." He believes that the direction of the bruit toward the axilla can be considered a good differential sign between aortic and internal mammary aneurism.

The diagnosis once established, the question of what surgical treatment to pursue arises. In one of these case reports it is noted that the simple ligation of the internal mammary vessel in the first interspace was followed by a reëstablishment of the collateral circulation, sufficient to cause a secondary hemorrhage which resulted fatally. The rich anastomosis between the intercostals and phrenics below suggests the impossibility of cure without radical extirpation of the sac. The resection of a portion of the chest wall and the costal cartilage following a preliminary ligation of the vessel in the first or second interspace and also below the aneurism, with a total extirpation of the sac, is a feasible procedure which may be carried out without injury to the pleura or danger of unpleasant sequelæ.

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ANEURISM OF THE PALMAR ARCHES*

WITH A REPORT OF AN ANEURISM OF THE DEEP ARCH CURED BY EXCISION

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THE rarity of aneurisms of the palmar arches is surprising, when we consider the vascularity and the great number of injuries to the hand. In France, where more attention has been given to this subject, we find several excellent systematic

studies. The American, English, Italian and German literature is confined to the reports of a few individual cases; the literature of the war, so rich in vascular injuries, has to date furnished but

few examples. We have been able to find sixty-one published cases. To this we are adding a personal case of an aneurism of the deep arch, making a total of sixty-two. Fifty-four involving the superficial arch and eight the deep arch.



FIG. 1.—Aneurism of the deep palmar arch. Palmar view showing the situation of the wound.



FIG. 2.—Aneurism of the deep palmar arch. Shows the infiltration of surrounding tissue from the secondary hemorrhages and the aneurism projecting through the wound.

Etiology.—

The general predisposing causes, which play such an important rôle in formation of aneurism in general, play but a minor part in the hand. This is due to the high incidence of trauma and the fact that more than half the

cases occur in children and in young adults. There are a few reported cases of atheroma of the arteries and two of spontaneous formation. Insufficient data

* Read before the American Surgical Association, April 18, 1924.

makes it impossible to determine the relationship of syphilis. The great majority of the aneurisms follow perforating or incised wounds by knives, nails, fragments of glass, etc. Contusions and occupational trauma are responsible for a few cases. It has followed cellulitis of the palm and Roux reports a case following the reduction of a dislocated thumb.

Pathogenesis.—The course of events is as follows: In the traumatic cases, after the external flow of blood has been checked, the escaping blood infiltrates the surrounding tissue, becomes organized and encysted. The false sac may or may not communicate with the blood-vessel, if it does we have a false aneurism (arterial hæmatoma), or the extravasated blood is absorbed and a clot forms, sealing the wound in the blood-vessel wall. The clot organizes and becomes a cicatrix. This scar may give way or dilate under increased arterial strain. In the cases arising from external inflammation there is an actual pathological change produced in the external coat, which spreads to the essential middle

coat, and this becoming weakened dilates before the arterial thrust. In the spontaneous cases there is a fatty degeneration of the muscle fibres of the middle coat and a granular degeneration of the elastic fibres.

Symptoms.—The aneurisms vary in size from a pea to an apple, the average being the size of a small hazelnut. The history is of a punctured or incised wound of the palm which bleeds freely and in which the hemorrhage is difficult to check, occasionally there is nothing about the wound to make you suspect that you are dealing with anything other than an ordinary wound. A few cases have been caused by a single contusion, others by a series of repeated contusions received in the course of the patient's occupation.



FIG. 3.—Sac of aneurism,
3.5 x 3 cm.

Within five to ten days after the receipt of the injury, the patient notices a small pulsating tumor in the hand. The tumor has appeared as early as twelve hours and as late as five months. The original scar is often visible, the skin may or may not be discolored, sometimes it is ulcerated. The expansile pulsations are accompanied by a soft systolic murmur, a thrill is rare. The expansile pulsations are readily detected in true aneurisms, in the false the presence of clots may modify this symptom. The volume and expansibility of the tumor may be reduced or abolished by pressure on the brachial or by simultaneous pressure on the radial and ulnar arteries. The presence of sensory and motor symptoms can be explained by the relationship of the aneurism to the palmar nerve supply; they vary from slight weakness, tingling, numbness and anesthesia to excruciating pain and impotency of the hand. Over 80 per cent. of the reported cases have had repeated hemorrhages.

Course.—Abandoned to itself an aneurism may lead to serious consequences, fortunately it is situated in such an exposed region that the patient is forced to seek medical advice and the tumor rarely attains a large size. Early surgical interference yields a prompt cure. Occasionally, pressure

ANEURISM OF THE PALMAR ARCHES

ulceration of the skin is produced. Suppuration and necrosis may result from the original wound or arise from compression and the application of styptics. There are no reported cases of aneurism causing gangrene, but Keen reports a case of gangrene of the hand caused by injecting the sac with Monsell's solution, the gangrene necessitating an amputation at the wrist. Rupture with secondary hemorrhage is a frequent complication. Although few fatal cases have been reported, there are a number of cases in which the repeated hemorrhages have led to grave anæmias. Spontaneous cure is possible as evidenced by Verneuil and Taillaux cases.

Diagnosis.—The diagnosis in general is easy and is often facilitated by the history.

Synovial cysts, epidermal cysts, abscesses, lipomas, fibromas and sarcomas, due to transmitted pulsations, have been diagnosed as aneurism. On the other hand, aneurisms have been incised under the impression that they were abscesses, vascular sarcomas, lipomas. Dupuytren operated for a lipoma of the hand and found an aneurism.

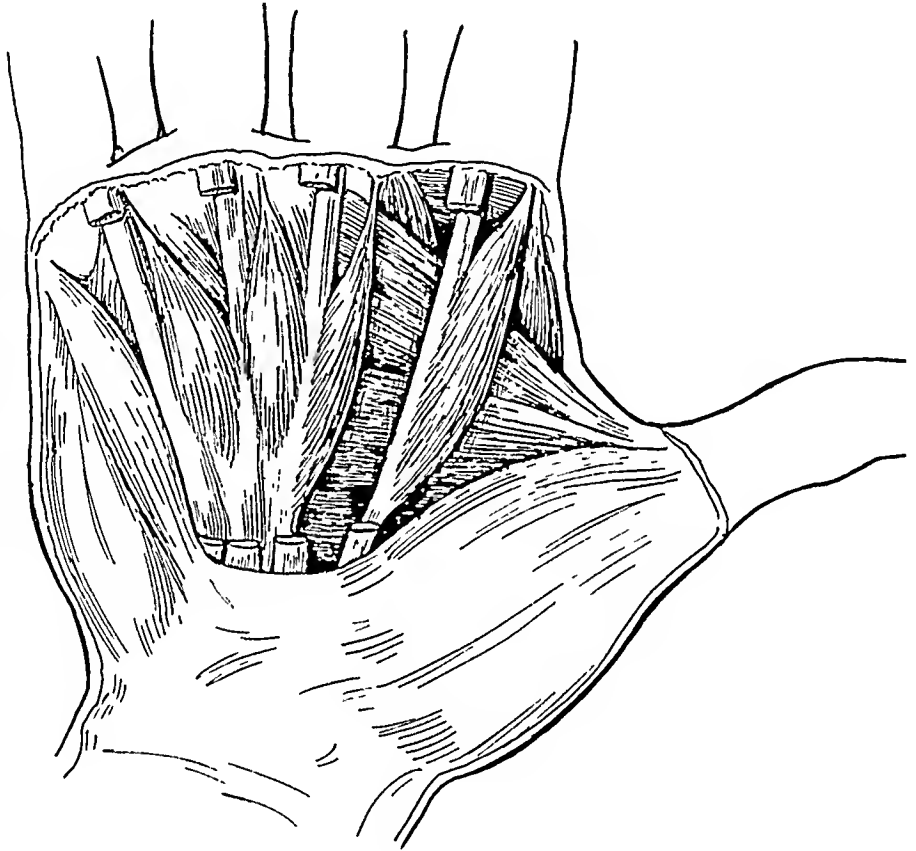


FIG. 4.—Shows insertion of the palmar lumbricales on the deep tendons. Note the arrangement on the index. Delorme takes advantage of this to enter the palm here. Also note the adherent mass of tendons and lumbricales of the little, ring and middle fingers. Direct access to the deep arch is hindered by this mass and in order to get a good exposure a retractor must be insinuated under this mass and the tendons retracted internally.

Verneuil operated for a fibroma and found the supposed fibroma to be an obliterated aneurismal sac.

Treatment.—The ideal treatment for aneurism involving the superficial or deep palmar arch is excision. Incision of the sac after ligation of both ends of the artery has been practiced with success. Schwartz considered excision of an aneurism of the deep arch to be difficult and contented himself with ligation of the radial and compression of the ulna. There are numerous cases on record of failure after the simultaneous ligation of the radial and ulna, and if we stop to consider the various anomalies of the vascular supply of the hand, it is evident that this unfortunate result could occur frequently.

Compression is uncertain and potentially dangerous and should not be used except as a temporary expedient until surgical help can be obtained.

As a prophylactic measure, all narrow penetrating wounds that bleed freely and are in possible relation to the palmar arches should be explored and both ends of the artery secured.

Exposure of the superficial arch is comparatively simple and needs no detailed description. For the exposure of the deep arch the choice of the incision depends on the situation of the aneurism. We have used Delorme's

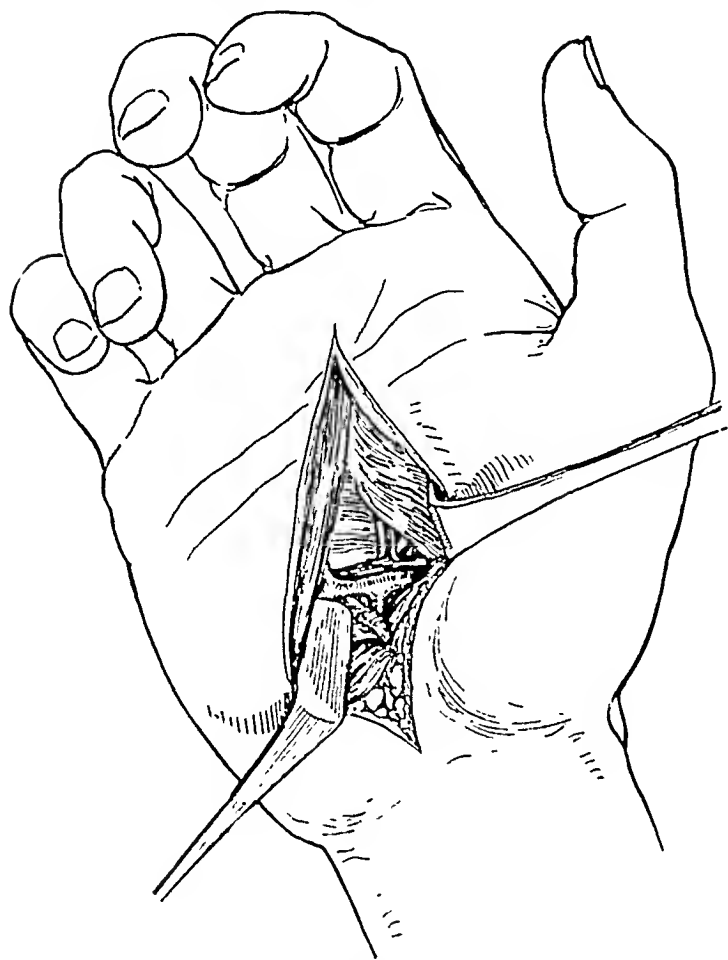


FIG. 5.—Shows mid-palmar incision for exposure of the deep arch. The index tendon with its lumbricale is retracted externally, the mass of flexors with their lumbricales are retracted internally. This is facilitated by flexing the four fingers. The arch is in the upper angle of the wound and is readily traced throughout. The motor branch of the ulna nerve crosses in front or behind the arch at the level of the third metacarpus.

a glass bottle against a water faucet and sustained an incised wound of the right palm at the junction of the thenar and hypothenar eminences. The wound bled profusely and sutures were required to check the hemorrhage. Eight days later the wound broke open and bled, ten days later a profuse hemorrhage took place, one week later a mild hemorrhage.

Physical Examination.—Healthy young adult, Wassermann negative. In the right palm, just below the junction of the thenar and hypothenar regions, there is an open wound 2.5 x 2 cm. The edges are everted and the surrounding soft parts are infiltrated with blood. A pulsating swelling about the size of a small hazelnut projects from the

internal palmar incision for the exposure of the deep arch in the hypothenar region and found it most satisfactory. Three of the incisions advocated by Delorme—the mid-palmar, the internal palmar and the dorsal internal incision—are shown in Figs. 5, 6 and 7. The fourth, a dorsal incision we have omitted, as it requires an excision of the upper part of the third metacarpal.

Traumatic Aneurism of the Deep Palmar Arch.—Male, aged twenty-six years, admitted to the service of Doctor Lyle at St. Luke's Hospital, May 8, 1923, referred by Doctor Dugdale. Family and past history immaterial. Present history: Four weeks ago broke

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wound. The pulsations are expansile in character and are accompanied by a systolic murmur. Pressure on the radial and the ulna arteries diminishes the swelling but does not obliterate it. The patient complains bitterly of pain in the little and ring fingers, both these fingers are flexed; the thumb is slightly adducted. The repeated hemorrhages have made the patient very apprehensive.

Operation, May 10, 1923.—Excision of aneurismal sac. An open wound being present, a strict Carrel treatment was carried out for two days as preparatory measure. Delorme's internal incision for exposure of the deep arch was used and gave an excellent exposure. The two main arteries with collateral branches were ligated and the sac excised. A wick drain was inserted and the wound closed. The pain ceased immediately. The wound healed in eight days and complete function was restored in four weeks. The patient has remained well. The false sac contained a hollow laminated clot 3.5×3 cm. in size and was connected with the deep palmar arch.

ABSTRACTS OF THE REPORTED CASES

We include aneurisms of the superficial and deep palmar arches and their collaterals and also certain cases in which the

trauma has been inflicted in the first dorsal interosseous space. We exclude cirroid aneurisms which are not uncommon. We consider Roberts, Mengers and Zichy-Wolanarski cases as being cirroids. We have also excluded the few rare cases of arteriovenous aneurisms of the hand.

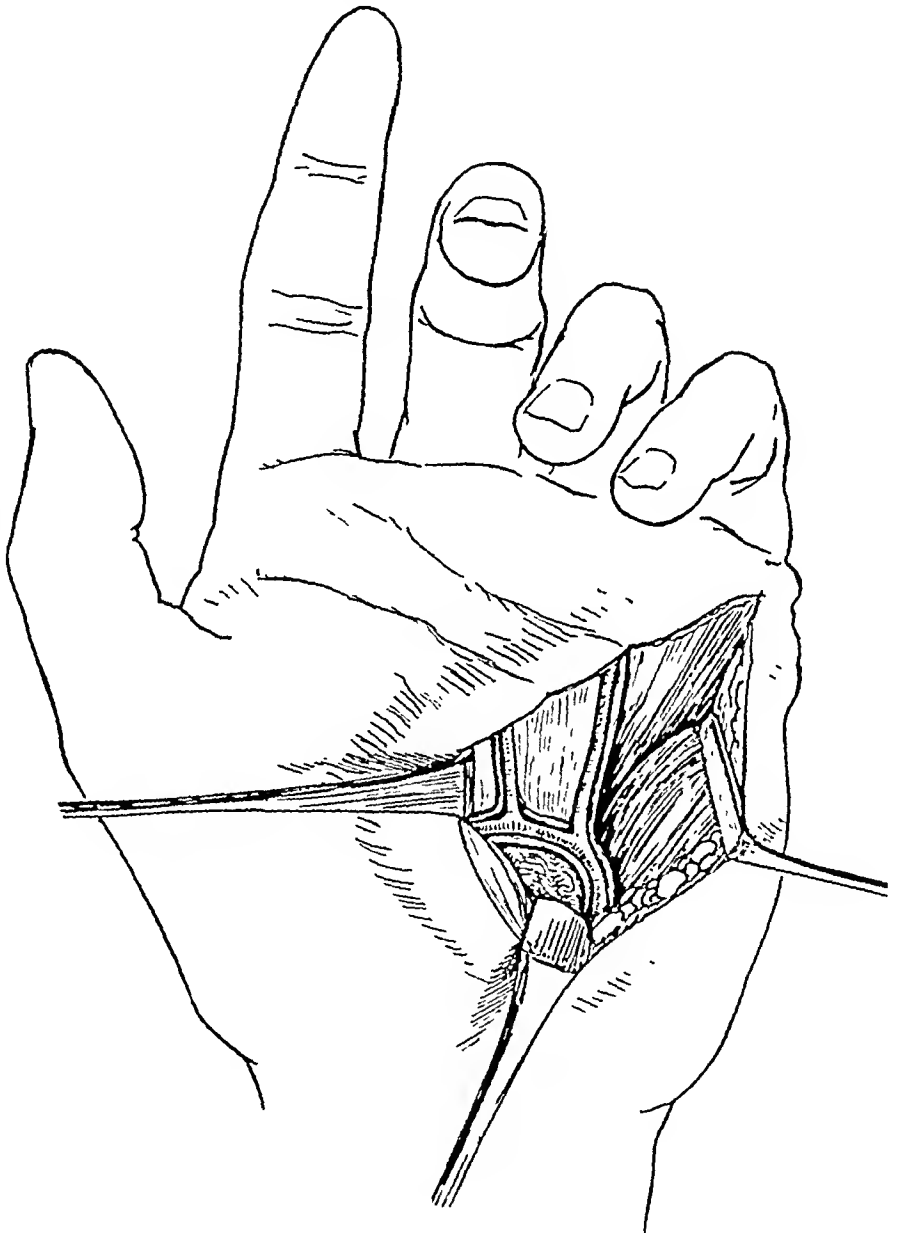


FIG. 6.—Internal palmar incision for exposure of the deep arch. The object is to enter between the flexor tendons and the external border of the hypothenar muscles. The flexor tendons with their tendon sheaths are retracted to the ulnar side. This is facilitated by flexing fourth and fifth fingers. The arch is found in the superior portion of the wound and can be readily exposed to the adductor of the thumb. The ulna nerve to muscles of thumb crosses sometimes in front, sometimes behind, this crossing takes place at the third metacarpus.

TABLE I.

Name	Age, yrs	Size, cause, location	Time of appearance	Notes	Treatment	Result
Albille..... 1877	..	Half size of hazelnut, cutting instrument; thenar branch of su- perficial palmar arch	15 days	Hemorrhages	Compression of radial	Cured.
Baumgarten..... 1920	70 M	Knife, thenar left <i>deep</i> <i>palmar</i> arch	4 days	This is the 5th published case of aneurism of deep palmar arch. Diffuse hematoma. Severe pain	Ligature of ulna, palmar arch and accessory branches	Cured.
Bellamy	23 M	Glass, hypothenar, su- perficial palmar arch	14 days	Repeated hemorrhages	Incision and ligation	Cured.
Bulteau..... 1881	8	Size of nut; glass, right hypothenar ulna where it forms superficial palmar arch	1 month		Compression of ulna, failure; electrolysis, failure; ligation of ulna at wrist, recurrence; liga- ture of radial at wrist and de- struction of sac with actual cautery	Cured.
Bouchacourt..... 1855	20 F	Knife	1 day	Hemorrhages	Compression, direct and indirect, failure; perchloride of iron, fail- ure; ligature of radial and ulna	Cured.
Caddy..... 1896	23 F	Hazelnut, glass, right superficial palmar arch	4 days	Pain only present on closing hand—not ten- der	Ligature of radial and ulna at wrist	Cured.
Chandelux..... 1890	38 M	Large nut, glass, inferior portion of 3rd interos- teous space	2 months		Excision	Cured.
Dalche et Menaud..... 1920	.. M	Small, knife, right hypo- thenar	Few days	Parasthesia	Intermittent compression	Cured.

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Davey..... 1855	20 M	Nut, glass, right superficial palmar arch	4 days	First noticed pain in ring finger	Compression direct and of radial and ulna; had slough from direct pressure	Cured.
Dervaux..... 1907	65 M	Egg, knife, first dorsal interosseous space		At original injury an attempt was made to secure both ends but one retracted, wound was packed	Excision, 3 months later	Cured.
Dittel*..... (See below)						
Dubar..... 1897	26 M	Shoemaker's knife deep palmar arch			Successive ligatures of radial, last to deep palmar arch	Cured.
Dupuytren..... 1834	5 M	Fragment of crockery, superficial palmar arch	12 days	Hemorrhages	Actual cautery	Cured.
Duvernoy..... 1870	50 M	Hazelnut, blacksmith repeated contusions right thenar superficial palmar arch	Gradual	Pain in hand	Direct compression, then compression of radial and ulna	Cured.
Griffiths..... 1897	23 F	Spontaneous, 1 1/4 x 1/2 in. hypothenar, branch to superficial palmar		Considered it a case of local endarteritis	Excision	Cured.
Guattani..... 1772	45 M	Coachman, chronic irritation of reins and whip, hypothenar superficial palmar arch	Gradual	Mistaken for abscess	Incised and packed with gauze	Cured.
Guérineau..... 1847	.. M	Fragment of porcelain superficial palmar arch	8 days	Hemorrhages	Indirect compression, ligature of ulna, galvano-puncture, recurrence in 29 days, galvano-puncture	Cured.
Guernnonpre and Besson..... 1902	26 M	Small nut, knife, superficial palmar arch			Excision 1 1/2 months after accident	Cured.

TABLE I.—Continued.

Name	Age sex	Size, cause, location	Time of appearance	Notes	Treatment	Result
Happel..... 1881	..	Acorn, catfish fin, left thenar, superficial pal- mar arch	8 days		Direct compression, failure; rup- ture of sac, sac opened, clots re- moved, ligature on radial in such a way as to include sac	Cured.
Haywood..... 1871	..	Glass, left superficial palmar arch			Incised sac, ligature above and below, ligatures cut through due to soft tissue. Ligature of ulna	Cured.
Herrgott..... 1860	..	Traumatic, superficial palmar arch			Compression, failure; double liga- ture	Cured.
Jahresberecht..... 1861	7	Nut, glass, left hypo- thenar superficial pal- mar		Grave anæmia from re- peated hemorrhages	Compression, failure; excision cure	Cured.
Jones, S..... 1867	29 F	Large, hypothenar	4 weeks	Pain with impairment of movement of fingers	Compression of radial and ulna	Cured.
Jones, S..... 1877	15 M	Hazelnut, glass, left palm	5 days	Recurrent hemorrhages <i>brachial</i>	Compression failure; <i>ligature of brachial</i>	Cured.
Keen..... 1882	Child	Sharp pebble, superfi- cial palmar arch		<i>Amputation of hand</i>	Compression and injection of Monsel solution, this was fol- lowed by gangrene of hand which necessitated amputation at the wrist	

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Keen and Gross 1893	38 F	<i>Recurrent aneurism</i> 12 years after, right hypo- thenar			Ligature of radial and ulna by Keen, original operation by Gross 12 years before. Gross performing three operations be- fore securing a cure. Operation on aneurism, ligature of ulna, ligature of brachial, original in- jury was bruise of hand husking cord—5 years of age, operated by local physician	Cured.
Kendirdzy and Reclus..	35 M	Cherry pit, below right hypothenar	3 months	Paræsthesia	Excision	
Kirwan..... 1921	5 F	Pigeon's egg, glass, right palm, superficial pal- mar arch	5 days	Thrill felt. Ring and little fingers flexed in palm	Excision	
Lamas..... 1922	31 M	Butcher knife, hypothe- nar, superficial palmar arch			Extirpation of sac. Operation was performed by Nin-Y-Silva	Cured.
Lannclonguc..... 1877	..	<i>Deep palmar</i> arch			Compression of radial and ulna for 24 hours	Cured.
Lannclonguc..... 1877	..	Superficial palmar arch		Threatened rupture	Incision of sac with ligature	Cured.
Lctenncur..... 1875	19 M	Glass, mid-palmar su- perficial palmar	1 month	Repeated hemorrhages severe pain	Compression, failure; compres- sion, rupture of sac	Cured.
Lyle..... 1923	26 M	Hazelnut, glass, palm, <i>deep palmar</i>	4 weeks	Pain and hemorrhage	Excision	Cured.
Marias..... 1920	14 M	Nail, right palm super- ficial palmar arch		Mistaken for abscess re- peated hemorrhage	Ligature of radio-palmar, ulna and collateral mistaken for abscess and incised, repeated hemor- rhages, true nature discovered three days later. Graveanæmia, required intravenous solution	Cured.

TABLE I.—Continued.

Name	Age sex	Size, cause, location	Time of appearance	Notes	Treatment	Result
Marques and Marques... 1920	M	Small egg, agricultural laborer, repeated contusions, right thenar <i>deep palmar arch</i>		<i>Mistaken for solid tumor.</i> Painful, right thumb and index interfered with	Ineised by mistake—ligature and extirpation of sac	Cured.
Marjolin..... 1859	12 F	Glass, superficial palmar arch	6 days		Intermittent compression	Cured.
Mauchaire..... 1908	31 M	Cherry pit, glass, right palm, superficial palmar arch	24 days		Excision of sac	Cured.
Mazade..... 1866	43 M	Knife, left palm, superficial palmar arch	9 days	<i>Abscess</i> and repeated hemorrhages	Compression, chloride of zinc, cauterization with <i>compression of brachial artery</i>	Cured.
Maydl..... 1896	33 M	Size of walnut, fork, right palm, <i>deep palmar arch</i>		Rapid growth <i>rendering hand useless</i>	Ineised and packed. Ligature of ulna where it becomes the deep arch	Cured.
Maydl.....	46 M	Size of walnut, knife, first interosseous space	3 weeks	Maydl's aneurism of rami dorsalis art radialis dextra	Excision 3 weeks after accident	
Mollicre..... 1885	19	File, right palm, superficial palmar arch	Several days	At first small, rapidly increased in size reaching maximum in 8th day	Profuse hemorrhage. Ligature superficial palmar arch, was not known if both ends were tied. <i>Recurrence</i> , excised, cured	Cured.
Morestin..... 1905	43 M	Small nut, <i>spontaneous</i> , left hypothenar and palm, superficial palmar arch		Spontaneous, patient recalls no contusion or wound	Excision 6 weeks after onset, it was necessary to sacrifice a small cutaneous nerve which was adherent to sac	Cured.

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Nélaton..... 1862	M	Traumatic, superficial palmar arch			Chemical cauterization—chloride of zinc	Cured.
Newbolt..... 1908	32 M	One inch in diameter, chisel, left palm, superficial palmar arch	2 months	Pain and numbness in index and ring fingers	Applied for treatment 2 months after wound. Incised sac wall and ligated superficialis volae, ulna and communication to deep arch	Cured.
Parker*..... (See below)						
Pozzi..... 1881	55 M	Pigeon's egg, glass, left hypothenar, superficial palmar arch	8 days	<i>Atheroma of arteries</i> severe pain	Direct and indirect compression, failure. Incision of sac and ligation of both ends of superficial arch and the digital artery entering sac	Cured.
Rastouil.....	26 M	3 x 2 cm., contusion superficial palmar arch	8 days	No wound, loss of power in hand. Sensory disturbances marked	Excision	Cured.
Regnault..... 1912	37 M	Pea, contusion, left superficial palmar arch	3 weeks	Naval gunner, contusions striking breech block to loosen it. No lues	Excision of sac	Cured.
Richet..... 1882	M	Revolver ball, superficial palmar arch			Rupture during treatment, compression	Cured.
Robertson..... 1897	M	Contusions, fight hypothenar superficial palmar arch	5 months	Pain and numbness. Was an engineer. Blow on hand against engine lever	Compression, failure; ulna ligated at wrist	Cured.
Robinson.....	35 M	Hickory nut, struck hand to loosen tap deep palmar arch	1 month	Possible lues, 15 years before	Excision	Cured.

TABLE I.—Continued.

Name	Age sex	Size, cause, location	Time of appearance	Notice	Treatment	Result
Roux..... 1837	25 M	Apple, sustained it re- ducing his own <i>dislo-</i> <i>cation of thumb</i> right thenar	1 day		This patient fell dislocated thumb and pulled in place himself, in- next morning large swelling, in- cised, hemorrhage. Compres- sion of radial and ulna failure, later actual cautery. <i>Two</i> <i>months later</i> came to Roux who tied radial, proposed to tie ulna hemorrhages, patient died be- fore ulna could be tied	Died.
Salmon..... 1890	25 M	Large nut, knife, 1st in- terosseous space			Excision	Cured.
Schwartz..... 1890	M	Knife, <i>deep palmar</i> arch			Ligature of radial and ulna 1 month after accident	Cured.
Taillaux et Millet..... 1891	10 M	Cherry pit, glass, super- ficial palmar arch	8 days	<i>Spontaneous obliteration</i>	Direct compression with <i>compres-</i> <i>sion of brachial, failure</i> ; large secondary hemorrhage, shock, incision of sac it was found that a spontaneous cure had taken place	Cured.
Tuffier.....	30 M	Size of franc, glass, hy- pothenar, terminal branch of ulna	8 days	Pain movements re- stricted	Excision	
Verstroete..... 1902	24 M	Hypothenar			Incision	Cured.

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Verneuil..... 1859	32 M	Glass, palm, superficial palmar arch	Several days		Compression of radial and ulna, failure, digital <i>compression</i> of <i>brachial</i> with forced extension of hand	Cured.
Verneuil..... 1866	M	Shoemaker's knife, superficial palmar arch	5 days		Compression and application of perchloride of iron, failure. Incision and ligature	Cured.
Verneuil..... 1874	..	Shlegmon of palm, superficial palmar arch		<i>Mistaken for abscess</i>	Indirect compression, failure injection of perchloride of iron. After multiple incisions for abscess of palm, secondary hemorrhages developed and later an aneurism appeared. Verneuil states that the arch was not injured by the incisions	
West..... 1856	17 F	Glass, left, between thumb and forfinger	10 days	Hemorrhages	Compression of radial and ulna. <i>Touriquet to brachial</i> cured by creosote	
Zynn, Vander H..... 1839	..	Wound palm left hand, spurious aneurism			Ligature of radial and ulna 1½ inch above wrist, recurrence 15 days later, second ligature of ulna 1 inch above first	
*Dittel..... 1863	15 M	Pea, knife, left palm, superficial arch	4 weeks	Sensory disturbances in ulna region after ligation	Cured by compression of brachial artery. This took 64 days and is a typical record of the pain and discomfort this method entails.	
*Parker..... 1852	19 F	Marble, glass, left superficial arch	10 days	Secondary hemorrhage fingers flexed in palm		

CONCLUSIONS

1. Aneurisms of the superficial palmar arch are not common, aneurisms of the deep palmar are extremely rare, only eight having been recorded.

2. The majority of the cases are caused by trauma with direct injury to the vessel wall, an insignificant number result from local or general pathological disease of the vessel wall, a small group are caused by chronic irritation and repeated contusions. Two cases have been reported as being spontaneous.

3. The best treatment is an early excision of the aneurism; this applies to both the superficial and deep arches.

4. As a prophylactic measure, all narrow penetrating wounds which bleed freely and are in possible relation to the palmar arches, should be explored and both ends of the artery secured.

5. Although these aneurisms do not occur frequently, we should remember their possibility and in the prognosis of a trauma to the palm reserve a place for them.

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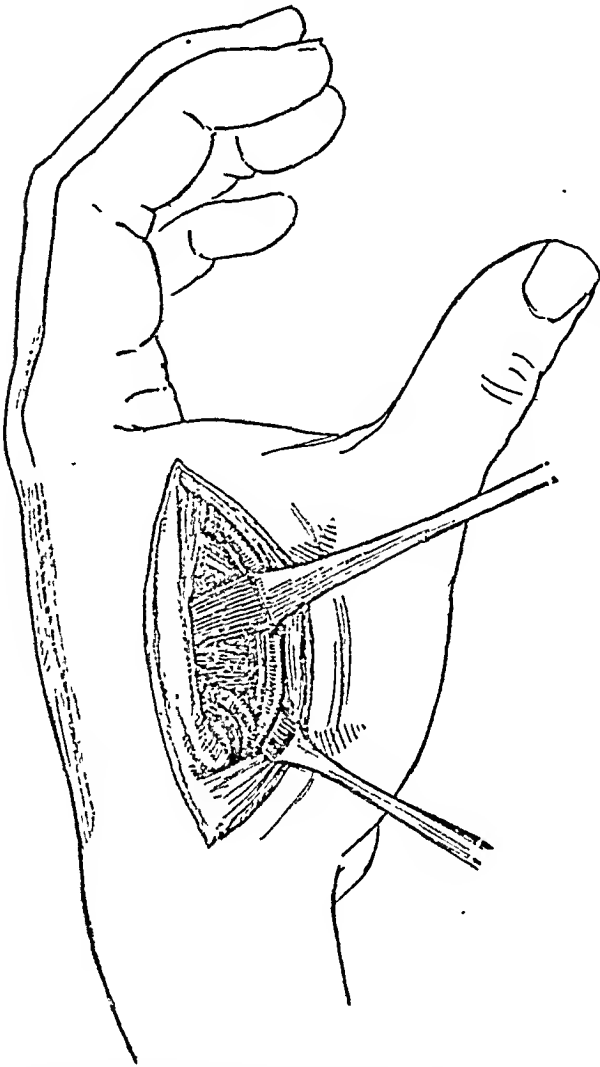


FIG. 7.—Dorsal internal incision for exposure of the radial origin of the deep palmar arch, this also gives access to the deep collateral of the index and thumb.

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THE INCIDENCE OF CONGENITAL CLEFTS OF THE LIP AND PALATE*

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I HAVE frequently been asked how often congenital clefts of the lip and palate occur, and have never been able to give a definite answer. The object of this paper is to determine as definitely as may be the incidence of these clefts. It is based on a study of the cases of congenital clefts of the lip and palate which have occurred up to March 1, 1924, in 24,158 deliveries in the Obstetrical Service of the Johns Hopkins Hospital † and in 3927 deliveries in the Hospital for the Women of Maryland.

A review of the literature shows that Fröbelius, in 1865, published a report based on the number of congenital clefts of the lip and palate found among 180,000 children admitted to the St. Petersburg Foundling Hospital between the years 1833 and 1863.

He estimated that these clefts occurred once in 2400 births and his figures have been generally accepted and constantly quoted. For a number of reasons, to be mentioned later, it is obvious that congenital clefts would occur more frequently in 180,000 total births than in the same number of admissions to any institution. Nothing further has been written on the subject.

One cannot determine the incidence of congenital clefts of the lip and palate from the records of any surgical clinic, as many children with these malformations die before they are presented for operation or admission; many of the simpler cases are operated on at home; and a considerable number are never brought for operation.

The number of these cases applying for operation at the larger surgical clinics varies according to the increase in the population of the district from which that clinic draws; according to the reputation of that particular clinic for success with these cases; according to the knowledge of the public at large that much can be done for the relief of these deformities and the consequent willingness of parents to bring children for operation.

It is possible that the frequency of occurrence of congenital clefts of the lip and palate may vary in different parts of the world. This may even be true in different sections of our own country and also there may be a difference in rural and urban communities. This seems to be indicated by the statistics compiled from the draft records of the defects found in the first 2,500,000

* Read before the American Surgical Association, April 19, 1924.

† I wish to thank Dr. J. Whitridge Williams, who very kindly placed at my disposal the records of the Obstetrical Department of the Johns Hopkins Hospital.

men examined for the United States Army in the world war, which show that in Vermont, at one extreme, the ratio of the occurrence of congenital clefts of the lip and palate per 1000 men examined was 1.55, while at the other end of the list stood Arkansas with a ratio of .16 per 1000. These statistics also showed that the incidence was highest per 1000 in the agricultural sections of the northern states.

As these figures are based entirely on the examination of men of military age no definite conclusion can be drawn from them as to the frequency of occurrence of congenital clefts, as those in females, those dying in infancy of malnutrition or following operation, and those operated on successfully are not included.

As far as I have been able to ascertain no mention is made of congenital clefts of the lip and palate in the official birth records now in use in this country or abroad, and in consequence accurate information cannot be obtained for the whole country or even for individual states, until uniform birth statistics are required which will cover this point.

It has been said that the frequency of occurrence of the types of congenital clefts may change and this was noted by Bruns, who quotes Langenbeck as saying in 1828: "In the past eight years the simple harelip has become a rare occurrence and the cleft palate a frequent phenomenon." He also quotes Walter in 1834, who says "double and complicated harelips occur at present more frequently than simple harelip, and much more frequently than thirty years ago." Bruns in 1873 confirms this idea from his own statistics. These observations may or may not be of value as the differences might have been caused by the fact that only the more difficult cases were brought into these particular surgical clinics.

In this study our interest is solely in the number of congenital clefts of the lip and palate which came to delivery, and not in those which are found so frequently in pathological embryos aborted in the early months of gestation.

For convenience and for purposes of comparison, I have separated the cases studied into three series.

SERIES A. The negro cases from the obstetrical service of the Johns Hopkins Hospital.

SERIES B. The white cases from the same clinic.

SERIES C. The white cases from the obstetrical service of the Hospital for the Women of Maryland.

SERIES A. NEGRO CASES FROM THE OBSTETRICAL DEPARTMENT, JOHNS HOPKINS HOSPITAL

Number of congenital clefts of the lip and palate in 12,520 deliveries—7. Nationality of mothers—United States, 7. Ages of mothers. Youngest, 21; oldest, 36; average, 26. Health of mothers. Good, 6; excessive vomiting (early months), 1. Mentality of mothers. Usual ward type. Ages, health and mentality of fathers. No routine note. Social status. Ordinary ward type.

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Primipara, 2; *multipara*, 5. Both of the primipara were 21 years old. Of the multipara, one child was the third of a 24-year-old mother; one was the fourth of a 26-year-old mother; one was the fourth of a 30-year-old mother; one was the fifth of a 30-year-old mother and one was the tenth of a 36-year-old mother.

Sex of child. Male, 3; female 4. *Year of birth*—1899, 1; 1902, 1; 1906, 1; 1907, 1; 1915, 1; 1920, 1; 1922, 1. *Legitimate*, 6; *illegitimate*, 1. *Prescutation*—L.O.A., 3; R.O.P., 3; R.O.A., 1.

Delivery. At term, 5. Spontaneous, 4; version, 1. Premature, 2. Both spontaneous. Seven and one-half months macerated foetus, 1; 8½ months child, died immediately after birth. *Weight at birth*. Heaviest, 3317 gms.; lightest, 2268 gms.; average, 2648 gms. *Length at birth*. Longest, 53 cm.; shortest, 42 cm.; average, 47.7 cm.

Malformation.‡ *Alveolar cleft lip*, 2 cases. In one female child, there was a right unilateral complete cleft of lip with notching of the alveolar process on right side. Palate intact. In one male child, there was a bilateral complete cleft of the lip with notching of the alveolar process on both sides. Palate intact.

Alveolar cleft lip and palate, 4 cases. In two males and two females, there were bilateral complete clefts of the lip, alveolar process and palate.

Alveolar cleft palate, 1 case. In a female child, there was a unilateral (side not given) complete cleft of the alveolar process and palate. Lip intact.

Associated anomalies, 3 cases.

In one girl, there was clubbing of feet and hands with polydactylism. (Died fortieth day.) In one girl, there was malformation of the mandible and enlarged thymus. In one boy, there was rudimentary hand and forearm and ankylosed elbow. (7½ months' foetus; still-born.)

Mortality, 5 cases. One 7½ months macerated male foetus, placenta luetic; one 8½ months female child, died after a few gasps, typically luetic, placenta negative; one female child still-born at term, placenta luetic; one male child died third day (mother had condylomata and the placenta was luetic); one female child died fortieth day of inanition. Three of these were typically syphilitic in appearance, although the Wassermann reaction was negative for the mother in 1; for the mother and father in 1; and for the mother, father and cord in 1.

SERIES B. WHITE CASES FROM THE OBSTETRICAL DEPARTMENT, JOHNS HOPKINS HOSPITAL

Number of congenital clefts of the lip and palate in 11,638 deliveries—13. *Nationality of mothers*—Bohemian, 1; Irish, 1; Roumania, 1; Russian, 2; United States, 8. *Ages of mothers*. Youngest, 17; oldest, 38; average, 25½. *Health of mothers*. Good, 10; excessive vomiting (in early months), 1; health poor, 1; tuberculosis of lungs, 1. *Mentality of mothers*. Ordinary ward type, 12; feeble-minded, 1. *Ages, health and mentality of fathers*. No routine note. *Social status*. That of ordinary ward patient.

Primipara, 7; *multipara*, 6. The ages of the primipara were 17, 19, 20, 22, 24, 26 and 33 years and 4 of the 7 children were illegitimate. Of the multipara, one child was the second of a 20-year-old mother; one was the second of a 23-year-old mother; one was

‡ In this paper the classification of Davis and Ritchie will be used. Group I. *Pre-alveolar* (process) *cleft*. (Lip cleft; alveolar process normal.)

Cleft of the palate may be associated with this group.

Group II. *Postalveolar* (process) *cleft*. (Palate cleft; alveolar process normal.)

Cleft of the lip may be associated with this group.

Group III. *Alveolar* (process) *cleft*. (Cleft follows incisor sutures.)

Clefts of the lip and palate are usually associated in this group.

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the second of a 25-year-old mother; one was the third of a 35-year-old mother; one was the third of a 38-year-old mother and one was the sixth of a 30-year-old mother. One of these children was illegitimate.

Sex of child. Male, 10; female, 3. *Year of birth*, 1905, 2; 1907, 1; 1909, 1; 1911, 2; 1915, 2; 1916, 1; 1919, 2; 1921, 2.

Legitimate, 8; *illegitimate*, 5. *Presentation*—L.O.A., 7; L.O.T., 1; R.O.A., 4; R.O.P., 1. *Delivery* At term, 12 Spontaneous, 9; mid-forceps, 2; low forceps, 1. Premature, 1. Spontaneous, 8 months. *Weight at birth*. Heaviest, 3954 gms.; lightest, 2085 gms.; average, 3250 gms. *Length at birth*. Longest, 52 cm.; shortest, 46 cm.; average, 49 cm.

Malformations. Prealveolar cleft, 5 cases. In one of these, a girl, the cleft was complete; in four boys, the clefts were incomplete. All were unilateral. The cleft was on the left side in two boys and one girl; the side was not given in two boys.

Alveolar cleft lip, 1 case. In a boy, there was a bilateral complete cleft of the lip with notching of the alveolar process on the left side.

Alveolar cleft lip and palate, 4 cases. In one, a girl, there was a bilateral complete cleft of the lip, alveolar process and palate. In three, all boys, there were unilateral clefts, one right and two left, of the lip, alveolar process and palate. Two of these were complete and one was incomplete.

Prealveolar and postalveolar cleft, 1 case. In this case, a boy, there was a unilateral left incomplete cleft of the lip with complete cleft of the hard and soft palate, the alveolar process being intact.

Postalveolar cleft, 2 cases. In both cases, a boy and a girl, there were complete clefts of the soft palate, the alveolar process and lip being intact.

Associated anomalies, 2 cases. In one boy, there was a stricture of the ureter and hydronephrosis. (Died 5th day.) In one girl, there were bilateral club feet and polydactylism of the right hand. (Died 1st day.)

Mortality, 6 cases. One girl died on the 1st day, one hour after birth. (Bilateral club feet, polydactylism.) One boy died on the 5th day. (Stricture of the ureter and hydronephrosis.) One boy died on the 21st day. (Bronchopneumonia, post-operative.) One boy died on the 24th day. (Bronchopneumonia and inanition). One boy died on the 35th day. (Inanition.) One girl died when 8 months old. Cause not given. In none of these cases was syphilis suspected or demonstrated.

SERIES C. WHITE CASES FROM THE OBSTETRICAL DEPARTMENT OF THE HOSPITAL FOR THE WOMEN OF MARYLAND

Number of congenital clefts of lip and palate in 3927 deliveries, 4. *Nationality of mothers*—United States, 4. *Ages of mothers*. Youngest, 27; oldest, 28; average, 27½ years. *Health of mothers*. Good, 3; nasal sinusitis, off and on during pregnancy, 1. *Mentality of mothers*. High grade. *Social status of mothers*. High grade. *Ages of fathers*. Youngest, 26; oldest, 55; average, 37¾. In one instance, the father was 28 years older than the mother and in another 15 years older. In one instance, the mother was 1 year older than the father and in one instance, the ages of the parents were equal. *Health of fathers*. Good, 4. *Social and mental status of fathers*. High grade, 4.

Primipara, 4. *Sex of child*. Male, 4. *Year of birth*. 1918, 2; 1919, 1; 1922, 1. *Legitimate*, 4. *Presentation*. L.O.A., 4. *Delivery*. At term, 4. Spontaneous, 3; low forceps, 1. *Weight at birth*. Highest, 3615 gms.; lowest, 3153 gms.; average, 3322 gms. *Length at birth*. Not noted.

Malformations. Alveolar cleft lip and palate, 3 cases. In two boys, there were bilateral complete clefts of lip, alveolar process and palate. In one boy, there was a unilateral left, complete cleft of lip, alveolar process and palate.

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Postavicular cleft, 1 case. In a boy, there was a cleft of the posterior third of hard palate and all of soft palate, the lip and alveolar process being intact.

Associated anomalies, 1. In this case, a boy, there was unilateral club foot on the right side (cleft on left side), and slightly bifid nose.

Mortality, 0. All of these cases were operated on and lived. The youngest being now 2 years old. Syphilis was not suspected or demonstrated in any of these cases.

GENERAL SUMMARY OF THE ENTIRE SERIES

Number of congenital clefts of the lip and palate in 28,085 deliveries—24. *Nationality of mothers*—19 were natives of the United States; 1 was a Bohemian; 1 was Irish; 1 was Roumanian and 2 were Russians. *Color*. White, 17; black, 7.

Ages of the mothers. Second decade, 2; 17 and 19 years. Third decade, 15; one each, 22, 23, 25 and 28 years; two each, 20, 21, 24 and 26 years; three each, 27 years. Fourth decade, 7; one each, 33, 35, 36 and 38 years; three each, 30 years. The average age of the mothers of Series A was 26 years; in Series B was 25½ years; in Series C was 27½ years, with a general average of 26⅓ years.

Health of the mothers. In the negro series, it is probable from the appearance of the child and placenta that four mothers were syphilitic, although all tests were negative. All of these reported themselves in excellent health. One of the white mothers complained of "poor health" at the time of conception and another of tuberculosis of the lungs. Two mothers, one white and one colored, reported excessive vomiting during the first 2½ months of pregnancy. Otherwise, the health of the mothers was excellent.

Mentality of mothers. High grade, 4; ward type, 19; feeble-minded, 1. *Health of fathers*. This was noted in only 3 cases in the Johns Hopkins Hospital series and all of these were in good health. In the 4 cases in Series C, the health of the fathers was excellent. *Mentality of fathers*. High grade, 4; ward type in those mentioned, 3. *Primipara*, 13; *multipara*, 11. *Sex of child*. White, male, 14; female, 3. Negro, male, 3; female, 4. Total, male, 17; female, 7.

Years of birth. 1899, 1 case; 1902, 1 case; 1905, 2 cases; 1906, 1 case; 1907, 2 cases; 1909, 1 case; 1911, 2 cases; 1915, 3 cases; 1916, 1 case; 1918, 2 cases; 1919, 3 cases; 1920, 1 case; 1921, 2 cases; 1922, 2 cases. *Legitimate*. White, 12; negro, 6. Total, 18. *Illegitimate*. white, 5; negro, 1. Total, 6.

Presentation. L.O.A., 14; L.O.T., 1; R.O.A., 4; R.O.P., 4; not given, 1.

Delivery. In 21, delivery was at term; in 3, the birth was premature. The labor was spontaneous in 19 cases; 13 white and 6 colored. Mid-forceps and low forceps were used in 2 cases each, all being whites. There was 1 version in a negro woman with a contracted pelvis. Of the 3 premature births, one was white, 8 months; and two were colored, 7½ and 8½ months. *Weight at birth*. White, highest, 3954 gms.; lowest, 2085 gms.; average, 3263 gms. Colored, highest, 3317 gms.; lowest, 2268 gms.; average, 2648 gms. *Length at birth*. White, longest, 52 cm.; shortest, 46 cm.; average, 49 cm. Colored, longest, 53 cm.; shortest, 42 cm.; average, 47.7 cm.

Malformations.—*Prealveolar cleft* (cleft of the lip alone). The lip alone was cleft in 5 cases, all being in white children and all unilateral. One was complete (the cleft extending into the nostril) and 4 were incomplete. In 3, 2 males and 1 female, the clefts were on the left side, and in 2 male children, the side was not noted.

Alveolar cleft lip (cleft of the lip with notching of the alveolar process), 3 cases. In one negro girl, the cleft was unilateral complete with cleft and notch on the right side. In one negro boy, the cleft was bilateral complete with notching of both sides. In one white boy, the cleft was bilateral complete with notching of the alveolar process on the left side.

Alveolar cleft lip and palate (cleft of the lip with cleft of the alveolar process, hard

and soft palate), 11 cases. Seven were bilateral complete clefts, 4 of these being colored, 2 boys and 2 girls; 3 white, 1 girl and 2 boys. Three were unilateral complete clefts, all being in white male children, one being right and two left. One was a left unilateral incomplete cleft of the lip with complete cleft of the alveolar process and palate in a white boy.

Prealveolar and postalveolar cleft (cleft of the lip and palate, the alveolar process being intact), 1 case. In a white boy, there was an incomplete left-sided cleft of the lip with complete cleft of the hard and soft palate.

Alveolar cleft palate (cleft of the alveolar process and palate, the lip being intact), 1 case. There was cleft of the alveolar process and palate in one negro girl. The side was not given.

Postalveolar cleft (cleft of the palate alone), 3 cases. There was cleft of the posterior third of the hard and soft palate in 1 boy, and of the soft palate in two cases, one boy and 1 girl, all being white.

Associated anomalies. In 6 cases, there were other congenital anomalies, associated with lip and palate clefts. Three of these were in white children. One, a boy, had a stricture of the ureter and hydronephrosis and died on the 24th day; one girl with bilateral club feet and polydactylism of the right hand, died on the first day; one boy, who had a slightly bifid nose and a club foot on the right side (the cleft being on the left side) still survives. Three were in negro children; one of these, a girl, had clubbing of the feet and hands and polydactylism of feet and hands, died on the 40th day; one girl had enlarged thymus and malformation of the mandible, was still-born at term; one boy, a 7½ months macerated fœtus, had a rudimentary hand and forearm and ankylosed elbow.

Mortality. Within 8 months, 11 died out of the 24 cases. One was a macerated 7½ months negro male fœtus; one was a 8½ months negro girl, who died after a few gasps; one negro girl was still-born at term; one white girl died the first day, one hour after birth; one negro boy died the third day, luetic; one white boy died the fifth day, stricture of the ureter and hydronephrosis; one white boy died the twenty-first day, post-operative bronchopneumonia; one white boy died the twenty-fourth day, inanition and bronchopneumonia; one white boy died the thirty-fifth day, inanition; one negro girl died the forty-second day, inanition; one white girl died when 8 months old, cause not given.

COMMENTS

Five out of twenty-four of the mothers were of foreign birth, but this appears to have no significance. There is nothing noteworthy in the ages of the mothers. Bad health of the mother or father, or both, at time of conception and of the mother during the early months of pregnancy has been considered a possible cause for these malformations, as has also been excessive vomiting during the first two and one-half months of pregnancy, and these facts should be borne in mind. There was excessive vomiting during the first and second months in three instances. One mother had pulmonary tuberculosis at time of conception. Another had "poor health" at time of conception.

It has been claimed that syphilis is the definite factor in causing these malformations, and there was probably syphilis in 4 cases, all of these being in Series A. From this number (4 out of 7 cases) of apparently syphilitic children with congenital clefts of the lip and palate, it might be inferred that syphilis played a definite part in the etiology, at least in the negro group.

We must bear in mind, however, that the majority of syphilitic children, both black and white, are born without this malformation. In Series B and C, no case of syphilis is recorded and this seems to refute the idea, at any rate for the white group.

Low-grade mentality of the parents has also been suggested as a possible cause of congenital clefts of the lip and palate. In the cases studied, only one mother is listed as feeble-minded. The mentality of the others was sufficiently normal to excite no comment.

The difference in the ages of the parents has also been considered a possible etiological factor. In one instance, the mother (feeble minded) was twenty years old, and the father (the girl's own father) was fifty-three years old, a difference of thirty-three years. In another instance, the father was fifty-five and the mother twenty-seven; and in another there was fifteen years difference. These were the most marked instances of difference in the ages of the parents in this series.

Maternal impressions were not recorded on the majority of the histories, and although interesting they are of no particular importance as etiological factors.

Although no notes were found in the family histories of the occurrence of similar congenital clefts, heredity undoubtedly plays an important part in the occurrence of these clefts of the lip and palate. The percentage given by different authors varies between 15 per cent. and 20 per cent. In my own cases, I have noted about 19 per cent. with a family history of congenital clefts.

It has been said that these congenital malformations occur more frequently in illegitimate than in legitimate children. In this series, 18, or 75 per cent., were legitimate and 6, or 25 per cent., were illegitimate; all of these were in Series A and B. Inasmuch as one-fourth of the children were illegitimate, notice must be taken of this fact; but I question the importance of illegitimacy as an etiological factor.

Doubt has been expressed by those who seldom see negro patients as to whether congenital clefts of the lip and palate ever occur in this race. From case reports elsewhere and from the number reported in Series A, we can conclude that the occurrence is not infrequent, but that it is not so common as in the white race.

The question of social status and environment is of considerable interest. The majority of the patients in the Johns Hopkins Hospital Series A and B, were of the public ward and out-patient service type. Those from the Hospital for the Women of Maryland, Series C, were of the private ward class. It has been generally accepted that a greater proportionate number of these malformations occur among the children of individuals of the lower and more ignorant classes, whose nutrition and hygienic surroundings are poor, than among those whose environment is all that could be desired and whose mental attainments are of higher degree.

In 12,520 deliveries of negro women in Series A, 7 congenital clefts of the lip and palate were found, or 1 in 1788+. In 11,638 deliveries of white women in Series B, 13 congenital clefts were found, or 1 in 895+. In 3927 deliveries of white women in Series C, 4 congenital clefts were found, or 1 in 981+. Taking the white series together, we find in 15,565 deliveries, 17 clefts, or 1 in 915+; combining all the series, in 28,085 deliveries, there were 24 clefts, or 1 in 1170.

In other words, in series A, where all conditions were most unfavorable, congenital clefts of the lip and palate occurred comparatively much less often than in series B and C. It may be that these clefts occur less frequently in the negro race than in the white, irrespective of environment, etc., but if this consideration is left out, these figures seem to upset the theory as to social status and environment. A comparison of series B and C show that clefts occur in the white public ward cases (1-895+) more frequently than in the private ward cases (1-981+), but the comparative difference is not great when we take into consideration the vast contrast between the environment and social status of these groups.

We find that 13 out of 24, or 54+ per cent., of the entire series were first children. Eleven white mothers were primipara as compared with 2 negro mothers, which shows that the proportion of congenital malformations of the lip and palate were greater in white primipara than in negro primipara. On the other hand, there was a greater proportion of negro multipara, 5 out of 7, as compared with the white multipara, 6 out of 17.

Haug in 1904 collected from the literature 2352 cases of congenital clefts operated on in various surgical clinics and found that 64.3 per cent. were males and 35.7 per cent. were females. In this series there were 7 females, or 29.17 per cent., and 17 males, or 70.83 per cent. In other words, these clefts occur much more frequently in male than in female children.

The first delivery in the out-patient Obstetrical Service of the Johns Hopkins Hospital was on January 1, 1895, and the first congenital cleft occurring on this service was on July 14, 1899, or four and one-half years later. The first delivery in the Obstetrical Ward of the Johns Hopkins Hospital was on August 17, 1896, and the first congenital cleft on this service occurred on July 22, 1902, or about six years later.

Nothing abnormal was noted during pregnancy, in the type of presentation and in the course of labor in this series. Delivery was at term in 87 per cent. of the cases.

The average weight of a full term normal white infant at birth is 3250 gms. The average weight in this series is 3263 gms., which is approximately normal. The average weight of a full term normal negro infant at birth is 3104.8 gms. The average weight of this series is 2648 gms., which is considerably less than normal.

The average length of a full term white normal infant at birth is 49.64 cm.

CONGENITAL CLEFTS OF LIP AND PALATE

The average length of this series of infants is 49 cm., which is normal. The average length of a full term normal negro infant is 48.75 cm. The average length of this series is 47.7 cm., which is slightly shorter than normal.

From these figures, it can be said that the average weight and length of a full term white child with a congenital cleft of the lip and palate in this series of cases is equal to that of the normal white child at birth. In only one of the negro cases did the birth weight reach normal for this race. This may be accounted for by the state of health of the mothers, 4 out of 7 being probably syphilitic. Less favorable hygienic surroundings and possible malnutrition during pregnancy may also have had some effect on the weight of the children of the negro series.

The lip was cleft in 20 cases, 83+ per cent. of the series. In 5 of these, 25 per cent., the lip alone was cleft. In 15, or 75 per cent., there were in addition clefts of either the alveolar process or palate or both. In other words, clefts of the lip complicated with clefts of the bony structure were found three times as often as simple clefts.

The palate alone was cleft in 3 cases, 12.5 per cent., and the alveolar process and palate in one case, 4+ per cent. of the series. Therefore, clefts of the palate alone occurred less often (12.5 per cent.) than simple lip clefts (20.8 per cent.).

A comparison of the most severe types of clefts shows the following: *Alveolar cleft lip and palate* (cleft of the lip, alveolar process and palate) occurred 4 times in 7 cases in Series A; 4 times in 13 cases in Series B and 3 times in 4 cases in Series C. Of these in Series A, all were bilateral complete, in Series B, one was bilateral and in Series C, 2 were bilateral.

It is noteworthy that in Series A, 57 per cent. were in the bilateral group; in Series C, 50 per cent. were in this group, while in Series B, only 7+ per cent. were bilateral. Thus we find that the negro series showed the highest percentage of the bilateral type of cleft with the private ward, Series C, a close second.

Of the unilateral type in this same group, there were 3 cases in Series B and one in Series C, and if we consider these in connection with the bilateral group, we find in Series A, 5 per cent.; Series B, 30+ per cent.; and in Series C, 75 per cent. In other words, in the series with the highest mentality and most favorable surroundings, the comparative number of severe cases was greatest.

In the twenty cases with cleft of the lip, 2, or 10 per cent., were on the right side; 8, or 40 per cent., were on the left; 8, or 40 per cent., were bilateral and in 2, or 10 per cent., the side was not stated. This would make the occurrence of the clefts on the left side four times as frequent as on the right, and in this series the bilateral clefts occurred in the same proportion, which seems unusually large.

The record of 11 deaths out of 24 cases (11 out of 20, or 55 per cent., in

Series A and B) is interesting, as it shows the mortality to be extremely high, even in the hospital where every facility is at hand for proper handling and care. It stands to reason that outside where facilities are frequently lacking, the mortality must be at least as high and is very probably higher. Syphilis, inanition and bronchopneumonia have been the principal causes of death.

A follow-up of the cases in Series B showed that one each was living 15, 13, 3 and $2\frac{1}{2}$ years after leaving the hospital. In Series C, one each was living 6, $5\frac{1}{2}$, 5 and 2 years after discharge. In Series A, none could be located.

It is interesting to compare the frequency of occurrence of congenital clefts of the lip and palate with other congenital malformations and this was possible in Series A and B.

In 24,158 deliveries in the Johns Hopkins Obstetrical Service, the following congenital defects, in addition to the 20 cases of cleft of the lip and palate, were found: Amnion adhesions, glaucoma, muscle defect, absence of œsophagus, situs transversus and diaphragmatic hernia, one each; intra-uterine amputation, cystic kidney, anencephalus, two each, or one in 12,079; skeleton defect, teratoma, three each, or one in 8052+; anus imperforate, hemicephalus, tracheo-œsophageal fistula, four each, or one in 6039+; hernia, except umbilical, defects of intestines, six each, or one in 4026+; defects of digits, defects of the external ear, eight each, or 1 in 3019+; webbed fingers, nine, or one in 2684; hypospadias, nævus, eleven each, or one in 2196; acrania, 14, or one in 1725+; tongue tie, 19, or one in 1271+; hydrocephalus, 20, or one in 1207+; spina bifida, 21 or one in 1150, and club foot, 26, or one in 929+; multiple digits, 134, or one in 180+; umbilical hernia, 390, or one in 61+.

The above makes a total of 713, *i.e.*, one congenital defect (other than cleft lip and palate) in every 33+ children delivered. This seems to be an extremely high percentage of defects, although the greater number were not of serious nature. We find that only spina bifida, club foot, multiple digits and umbilical hernia occurred more frequently than congenital clefts of the lip and palate.

CONCLUSIONS

The incidence of congenital clefts of the lip and palate cannot be determined from a study of the admissions of these cases to surgical clinics or to institutions. Likewise, accurate data cannot be obtained on this point from the examination of male adults of draft age.

Definite conclusions cannot be drawn as to the relative importance of the various possible etiological factors, although in the negro series syphilis must be considered. Nothing unusual was noted during the course of pregnancy, labor and delivery, and the presentations were normal.

In 28,085 deliveries, 24 clefts of the lip and palate were found.

CONGENITAL CLEFTS OF LIP AND PALATE

Congenital clefts of the lip and palate occur in the negro race (in this series, 7 in 12,520 deliveries), but with less frequency than in the white (in this series 17 in 15,565 deliveries).

Environment and social status are apparently of little importance, as in the negro series, where conditions were most unfavorable, clefts occurred much less frequently (1-1788+) than in either white series. However, in the public ward white series, clefts occurred more frequently (1-895+) than in the private ward series (1-981+). The incidence in all the series together was 1 in 1170+; in the two white series 1 in 915. These figures show a frequency of occurrence much greater than that estimated by Fröebeli.

More than half the clefts were in first children.

The percentage of males was 70+, of females 29+ per cent.

Clefts of the lip on the left side and bilateral clefts were found equally often, each occurring four times as often as right-sided clefts.

The lip was cleft in 83+ per cent. of the cases. Of these in 25 per cent., the lip alone was cleft; in 75 per cent. there were, in addition, clefts of either the alveolar process or palate or both. The palate alone was cleft in 12.5 per cent. of the cases and the alveolar process and palate in 4+ per cent.

In Series C, with the highest mentality and with the most favorable surroundings, the relative number of alveolar cleft lips and palates, the most severe type of cleft, was greater than in the other white series, 75 per cent. as against 30+ per cent. This group of clefts occurred in 57 per cent. of the negro series.

The average weight and length of a full-term white child with congenital cleft of the lip and palate is equal to that of the normal child at birth. The average weight of the negro child with congenital cleft of the lip and palate is considerably less than that of the normal negro child at birth and the average length is slightly less.

Associated anomalies occurred in 25 per cent. of the cases. This is a much larger percentage than we ordinarily find in cases admitted for operation. The mortality during the first few months is extremely high, 11, or 45+ per cent., of the entire series. Syphilis, inanition and bronchopneumonia were the principal causes of death, although in addition five of these cases had associated anomalies.

Children, with congenital clefts, who live past the first year, apparently have a reasonably good chance of surviving.

The occurrence of congenital defects, other than those of the lip and palate, in the Johns Hopkins cases is astonishingly high, one in every 33+ deliveries.

I realize that the number of cases studied in this series is too small to allow accurate conclusions to be drawn. However, certain information has been gained which is of considerable interest and value, and which sheds light on the incidence of congenital clefts of the lip and palate, at least in this locality.

JOHN STAIGE DAVIS

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ŒSOPHAGOTOMY FOR FOREIGN BODIES IN THE ŒSOPHAGUS*

BY PHILEMON E. TRUESDALE, M.D.

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FOREIGN bodies arrested in the œsophagus command attention because their presence is a source of great danger and their removal becomes immediately a very vital problem. Children often fall victims to this accident because they are in the habit of placing a great variety of articles in their mouths. In adults, about 62 per cent. of the cases are due to chicken bones, fish bones, or poorly fitted artificial teeth.

In regard to the situation at which foreign bodies may become lodged, it has been observed that small pointed bodies which easily penetrate the mucous membrane may become fixed at any point in the œsophagus. Very large bodies usually cannot pass the isthmus and remain fast in the pharynx. The larger variety of foreign body which has passed through the pharynx most frequently lodges at those places where, under normal conditions, the œsophagus is constricted, 1st, just behind the cricoid cartilage, 2nd, the middle constriction which is about opposite the bifurcation of the trachea and on a level with the 7th cervical vertebra, and 3rd, the inferior constriction, where the œsophagus passes through the diaphragm. Foreign bodies which reach the inferior constriction and stop there, usually have been forced down by attempts to get them into the stomach with bougies. The spontaneous descent of larger foreign bodies to the lowest constriction is rare. The majority of foreign bodies remain lodged in the cervical portion of the œsophagus. Kronlein explains this by the fact that here the œsophagus is wedged in between the vertebral column, the larynx, the thyroid cartilage and in the aperture of the thorax.

Among the earliest writers upon this subject, the French appear to have contributed the most valuable monographs. Although Goursald (cited by Guattani, *loc. cit.*) was the first to perform œsophagotomy for this condition in 1738, Guattani (*Memoirs de l'Academie de Chirurgie*, Tome 1, 1819) was the earliest systematic writer on the technic of œsophagotomy. Sir William Ferguson in his surgery published a valuable treatise in which he cautioned his readers that however simple the operation seemed on the dead subject, it was attended with much labor on the living and the surgeon could escape its hazards only by the most painstaking dissection. Among American surgeons the contributions of Dr. David Cheever, of Boston, in a monogram published in 1868 were notable. He made an exhaustive review of the literature on the subject and reported three cases operated upon by himself.

He emphasized the fact that attempts at extraction by mouth were capable of infinite mischief; that owing to the structure and connections of the œsophagus its walls are especially prone to perforations and such accidents

* Read before the American Surgical Association, April 18, 1924.

have occurred from the use of the probang. The œsophagus is united to the prevertebral muscles only by the loose connective tissue. On this account it is readily pushed before the probe and injured. In this respect it is analogous to the membranous portion of the urethra and should be handled with meticulous care. Deaths from efforts to remove foreign bodies in the œsophagus through the mouth are more common than is generally supposed.

Ingalls (Ingalls, E. F., *Amer. Jour. Surg.*, Jan., 1912, p. 42), writing in 1912, said: "A few years ago the removal of foreign bodies in the œsophagus by means of the œsophagoscope was considered devoid of danger, but we know that fatalities may occur and we have reason to believe that in general there may be a large percentage of mortality."

Among the modern authorities the work of Chevalier Jackson (bronchoscopy and œsophagoscopy), of Philadelphia, stands out preëminently. He has perfected the operative technic through the œsophagoscope to a very high degree and thus placed a sharp limit on the cases needing the open operation. His mortality of 2 per cent. or less represents the most skilful work among trained operators. Jackson feels that the mortality in the hands of those without adequate training and experience must be many times greater than this. He regards the œsophagoscope in the hands of rough, careless and unskilled physicians as a dangerous and often fatal instrument. Moreover there are risks associated with the use of the œsophagoscope which he describes as "Complications and Dangers." Asphyxia from pressure of the foreign body or the foreign body plus the œsophagoscope is a possibility; faulty position of the patient, with faulty direction of the œsophagoscope may cause alarming symptoms from pressure upon the trachea, especially when the patient is under general anæsthesia. Prompt introduction of a bronchoscope with oxygen and amyl nitrite insufflation and artificial respiration may be necessary to save life. Whenever cocain is used the danger of poisoning cannot be ignored. Perforation of the œsophagus with the œsophagoscope, while rare in skilful hands, it is a recognized liability especially when the œsophageal wall is weakened by ulceration or trauma. In the presence of these pathological changes there exists a danger of making a false passage or entering one with the œsophagoscope. At the crico-pharyngeal constriction fatal œsophagoscopic perforation by inexperienced operators is very likely to occur. Here there is a weakly supported area in the œsophageal wall. Richardson (Dennis, *System of Surgery*, vol. iv, p. 233) refers to the liability of impaction of instruments used by mouth, thus requiring œsophagotomy for their release. Such are the dangers observed in every-day practice and avoided only by expert knowledge and perfected technic.

However, in spite of these discordant facts, endoscopic procedures for the extraction of foreign bodies in the œsophagus are generally considered preferable to, and safer than the operation of œsophagotomy providing the œsophagoscopist possesses adequate skill and equipment. Nevertheless, a method known to be safe in the hands of one possessing the necessary attainments may prove an unhappy adventure for another, ill-qualified by lack of training

and experience. The most able exponents of œsophagoscopy invariably refer to the "skill of the operator" as the *sine qua non* for success. By this reference I am sure that just ordinary skill is not implied. It is not to be construed as that degree of skill possessed by the average capable laryngologist. Even the moderately difficult cases demand talent, ingenuity, adroitness, perhaps consummate skill acquired only after many years of convergent practice.

In his chapter on "Acquiring Skill" Jackson remarks, "Endoscopic skill



FIG. 1.—Tooth-plate in œsophagus. Removed by œsophagotomy.

cannot be bought with the instruments. Repeated exercise of a particular series of manœuvres is necessary. As with learning to play a musical instrument, a fundamental knowledge of technic, positions and landmarks is necessary after which only continued manual practice makes for proficiency. Endoscopy is a purely manual procedure, hence, to know how is not enough, manual practice is necessary. Practice on the cadaver, on the rubber-tube manikin, and finally upon dogs, should be pursued for the education of the eye and the fingers. It is inhuman and impossible to obtain the preliminary experience on the living subject."

Providing a patient must receive prompt relief and is located in a district

remote from an endoscopic clinic, the method of dealing with the situation is of prime importance, because it is likely to make all the difference between a triumph and a fatal failure. No doubt more of these cases can wait and be transported long distances than exigencies of the situations usually appear to warrant. Notwithstanding this fact, the picture presented by a patient strangling, choking and partially stifled by a large foreign body

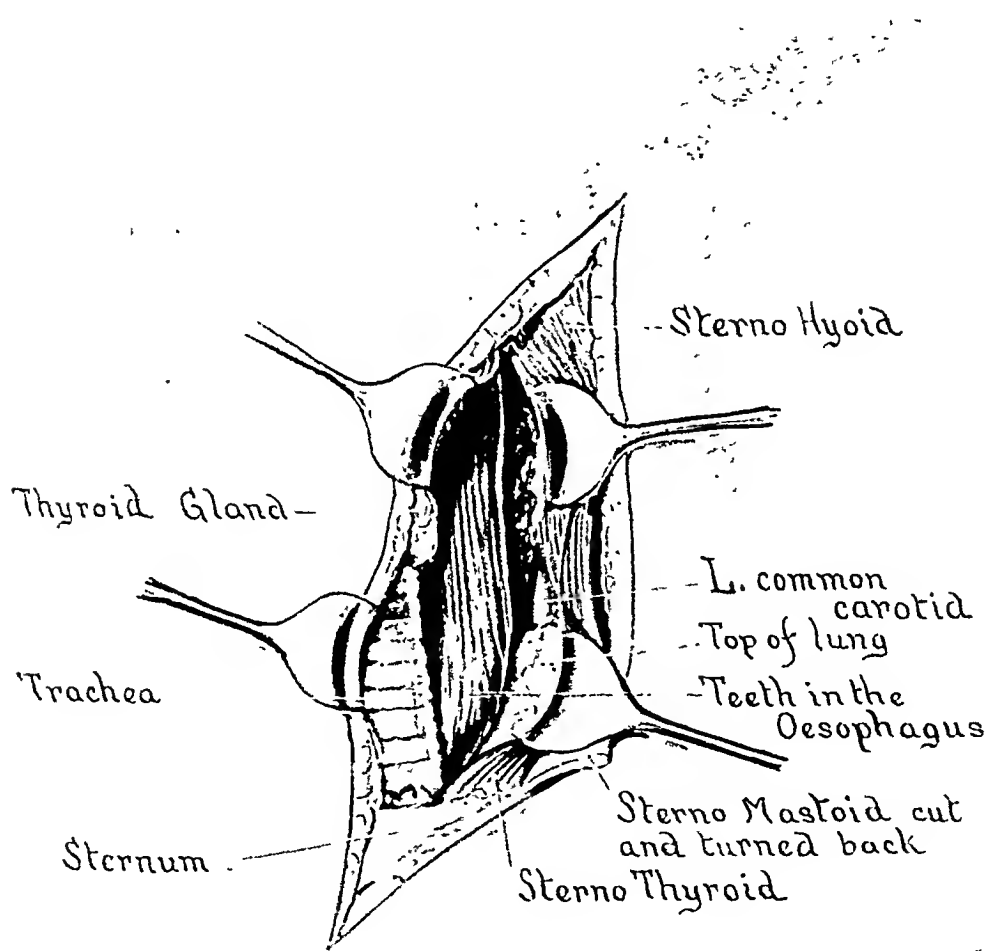


FIG. 2.—Structures met in approaching the œsophagus.

arrested in the œsophagus is sufficient cause for infirmity of purpose, fright and even panic on the part of his attendants. Four such cases have occurred in our community. Three are known to have died after bloodless methods at first presumably conservative, then followed by œsophagotomy.

The fourth case a male aged twenty-three was brought to our hospital from Warren, R. I. on September 6, 1923, two hours after he had accidentally swallowed a partial denture of the upper jaw. No attempts had been made to dislodge the plate except by the patient

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himself. He tossed about ceaselessly in efforts to move the foreign body up or down. Upon examination his appearance showed evidence of exhaustion and prostration. He was dyspnoëic and salivated freely. There was moderate swelling of the neck and marked tenderness at the suprasternal notch. Otherwise his physical condition was good. Pain was severe and persistent requiring hypodermic injections of morphia. The Rontgen film, Fig. 1, showed a dental plate in the œsophagus arrested opposite the 7th cervical vertebra and about at the aperture of the thorax.

A conference was held among members of the hospital staff and by telephonic communications with Dr. Chevalier Jackson of Philadelphia and Dr. Crosbie Greene of Boston, after which we reached the conclusion that under the circumstances the open operation offered this patient the best chance for recovery. Our decision was based upon the following premises

(a) The foreign body was large, horse-shoe in shape, with rough edges and impacted in the cervical portion of the œsophagus. (b) It was definitely localized and accessible. (c) The patient was dyspnoëic and weary. He could not swallow water without convulsive effort causing an aggravation of pain and soreness. (d) He was a young healthy adult with a long, lean neck and no enlargement of the thyroid gland. (e) No

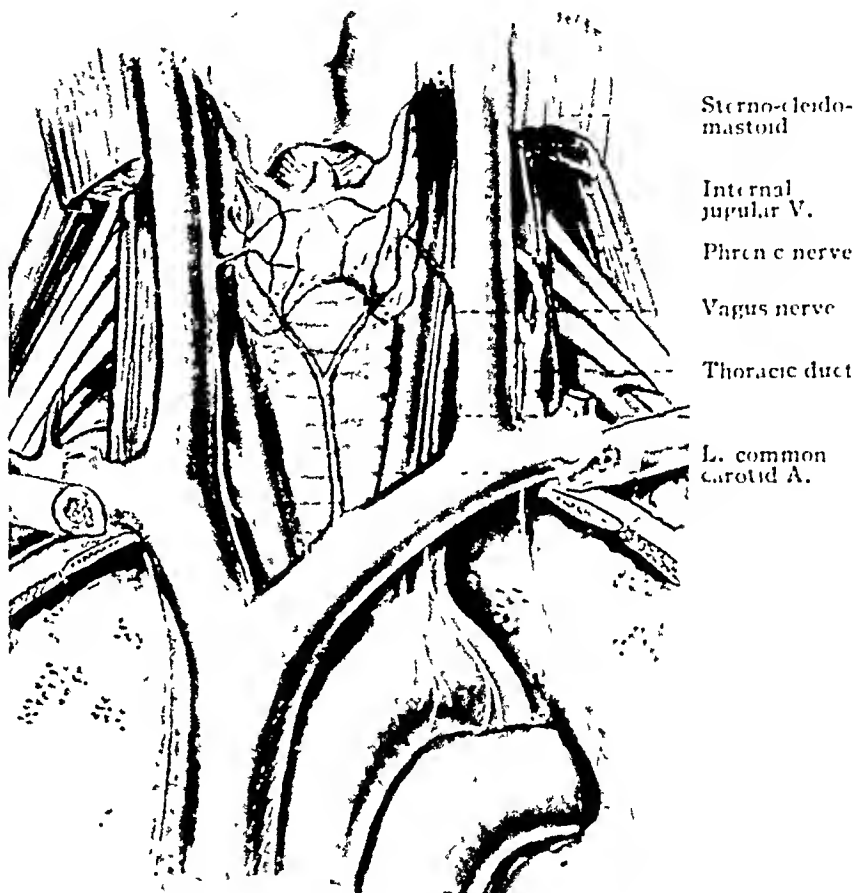


FIG. 3.—Deeper structures met in approaching œsophagus.

trial procedures had been undertaken, hence no complications had been superimposed. (f) Available for the operative effort were a laryngologist and a general surgeon. The former was very capable of doing those operations usual in the practice of laryngology but lacked expert familiarity with the use of the œsophagoscope. (g) There was neither equipment nor trained assistants with which to venture an endoscopic procedure.

Dr. Crosbie Greene recommended œsophagotomy. Dr. Chevalier Jackson believed that the denture could be removed by mouth but that local conditions should help determine the plan of operation. Inasmuch as about ten hours had elapsed since the first X-ray examination, another exposure was made because of the remarkable fact that many irregular foreign bodies including dental plates are known to have passed through the entire alimentary canal without injury to the patient. Lediard (*Clin. Soc. Trans.*, vol. xviii, p. 207) records a case in which the dental plate appeared at the anus nineteen days from the date of impaction. In our patient the foreign body had not changed its position. Therefore it was decided to proceed with the operation of œsophagotomy.

The patient was etherized and placed in the Fowler position with head extended and

turned to the right. The skin was painted with iodine after which an oblique incision was made following the anterior border of the left sterno-cleido-mastoid muscle and carried down over the sternum for a distance of 5 cm. (Fig. 2). Extending the incision down over the sternum proved advantageous in providing the maximum amount of room where it was needed most. After dividing the cervical fascia approach to the œsophagus was made through the lower carotid triangle guarding against injury to the structures contained therein. The sternal origin of the sternomastoid was severed and the muscle freely mobilized. The carotid sheath with its enclosed vessels was exposed as these structures merged from the superior thoracic aperture. (Fig. 2.) The sternomastoid

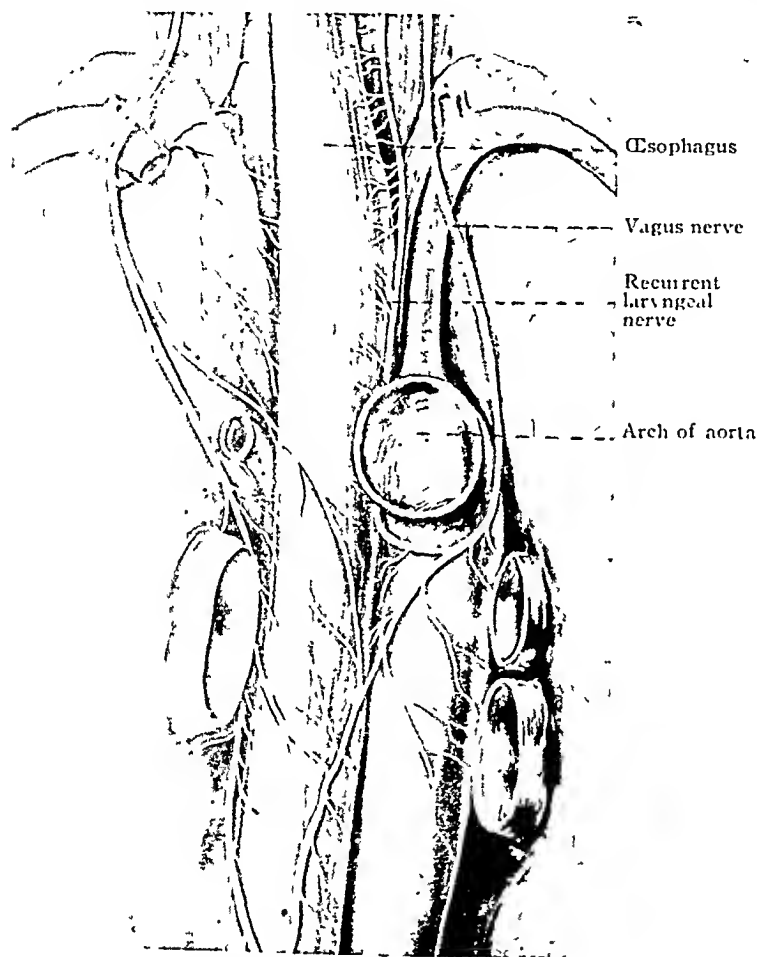


FIG. 4.—Relations of recurrent laryngeal nerve to arch of the aorta and œsophagus.

and large vessels were drawn to the left and the trachea to the right, with retractors, the thyroid gland showing plainly over the trachea. (Fig. 3.) Care being taken to avoid injury of the recurrent nerve, Fig. 4, the loose cellular tissue was separated by a method of blunt dissection and the œsophagus exposed. At this point the pleura was nicked and disturbed the even course of events. With this repaired the location of the dental plate in the œsophagus could be defined readily. Although the foreign body was fixed there was no evidence of puncture. Before incising the œsophagus a small sponge soaked in 70 per cent. alcohol was packed in the wound long enough to afford some protection against infection. The

vertical incision in the œsophageal wall was made somewhat far back in order to avoid the recurrent nerve. Through a 4 cm. opening, Fig. 5, it was with considerable difficulty that the dental plate was dislodged and extracted, so tightly was it embraced by the œsophageal fibres. This experience was not unique for Mr. George Lawson (Clin. Soc. Trans., vol. xviii, p. 292) in a similar operation found the plate so firmly fixed into the wall of the œsophagus that it required division with bone forceps before its removal was possible.

The opening in the œsophagus was then closed with a double layer of interrupted sutures of fine silk. A rubber tissue drain was placed in the lower angle of the wound. The skin sutures used only at the upper angle were removed on the fourth day. The patient was nourished by means of a Rhefuss tube. A small œsophageal leak appeared

on the seventh day. This closed in three days. He was discharged on the sixteenth day. There remained only a superficial granulating area. Deglutition was natural and the voice remained normal. At the end of six months he appears to have no stricture of the œsophagus and suffers no inconvenience from the scar.

The dangers of œsophagotomy for foreign bodies are by no means negligible. The primary risk of the operation is considered to be large. The chief causes of death are hemorrhage, shock and infection. Injury to the recurrent laryngeal nerve is not uncommon. Mr. Cock (Jacobson and Steward, vol. i, p. 563) reported a

case of this sort.

The patient was a singer. As a result of this accident his fine tenor voice was replaced by a bass.

Stricture of the œsophagus may also follow the operation. The

mortality, however, cannot be considered very high among the surgeons who first performed this operation.

Of 135 œsophagotomies reported by Egloff (Beitrag zur klin. Chir., 1894, p. 143), dating from the first case by

Goursald in 1738,

to 1894, 100 recovered.

Of operations performed in the first three days, 46 showed a mortality of 19.5 per cent. Most of these operations were performed by German surgeons.

It is doubtful if the high mortality, 20 per cent. to 42 per cent., referred to by Chevalier Jackson (*Ibid.*, p. 185) represents the results of this operation in the hands of experienced surgeons under favorable conditions. It is more probable that this high mortality rate can be attributed to "overtreatment" in attempts at extraction by the many so-called "justifiable" procedures with probang and œsophagoscope so commonly advocated as first aid. Even under the guidance of skilled hands any prolonged instrumentation of the œsophagus must react unfavorably upon the chances of success by œsophagotomy.

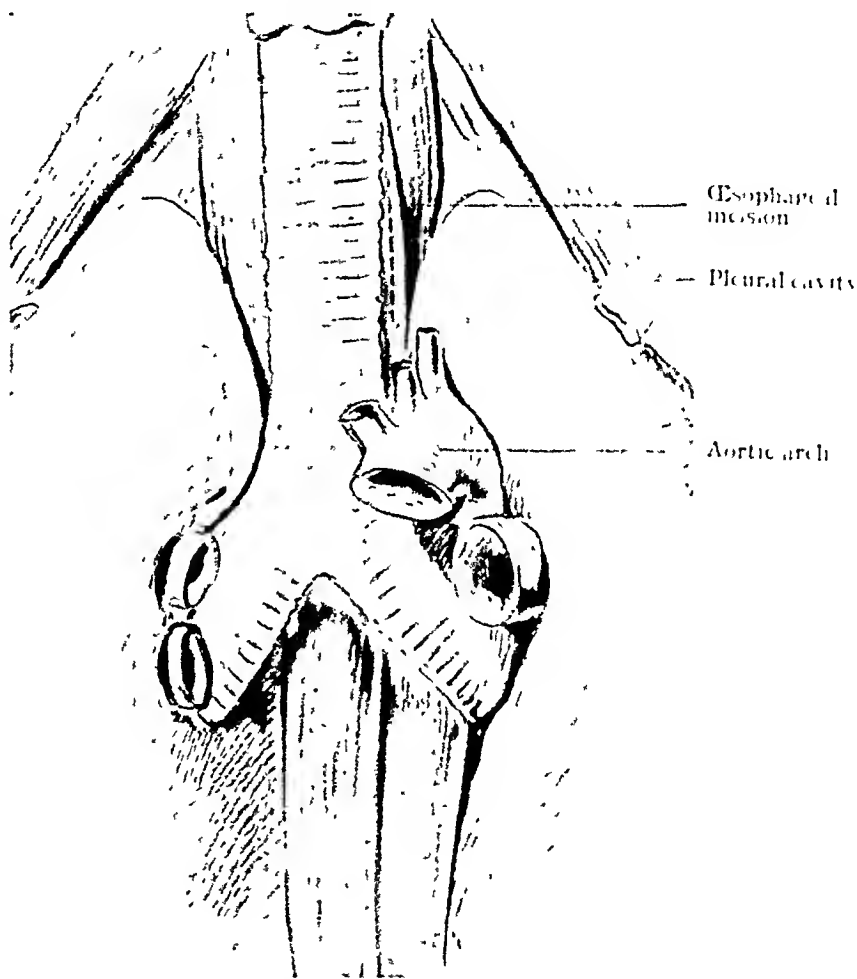


FIG. 5.—Mediastinal space showing proximity of pericardial cavity to œsophagus.

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Time which passes rapidly for the operator, is long and wears heavily upon the patient. Only the skilled endoscopist knows when to stop in the use of conservative methods. When the physician or laryngologist is convinced after a multiplicity of manœuvres that he cannot extract the foreign body, the patient may be fatally injured. The neck from its external aspects may not present ominous signs but danger lurks within. Trauma and exhaustion have done their part and surgery completes an ignoble record. When the foreign body is large, irregular and impacted, will there not be a better chance for the patient's life if œsophagotomy is done by a surgeon familiar with the anatomical parts to be met, than if extraction by mouth is undertaken by one who does not possess the proper instruments and has not thoroughly mastered the technical difficulties which the procedure entails?

These accidents happen many hundreds of miles from endoscopic clinics yet there are few regions where a capable surgeon cannot be reached within fifty miles. Whenever there is a possibility that the open operation may have to be done, would it not be more logical to study the case from every angle with a view to selecting the safest method available. That method may not represent the last word in the technical features pertaining to the treatment of these cases, but on certain occasions the first-born method may be found more expedient, fully as trustworthy and even less precarious. If œsophagotomy is undertaken only after "bloodless" methods fail, necessarily the mortality must be very high. Under favorable conditions it should not exceed 5 per cent.

In order that the open operation may have the best chance for success when it is indicated, it is essential that no preliminary probing of any sort by mouth be allowed. That feature more than any other contributed to the success of the case which I have reported. Surgery in this, as in the treatment of many other diseases, must not be chosen as a last resort if the aim is to save life. Although well nigh obsolete, I believe œsophagotomy is still a precious procedure in wisely chosen cases of foreign body in the œsophagus and the success of this operation is never enhanced by trial measures which shatter a patient's stamina and induce prostration. To have its fair chance in this particular dilemma, œsophagotomy must be given an unbroken field at the start.

END RESULTS IN SOME CONDITIONS ASSOCIATED WITH OR POSSIBLY CAUSED BY GOITRE*

BY MARTIN B. TINKER, M.D.

OF ITHACA, N. Y.

THE end results reported by Charles H. Mayo, Crile, Ochsner, Frazier, Judd, Pemberton, Lahey, and others have covered nearly all points thoroughly and have convinced the medical profession and the public of the value of goitre surgery as is evidenced by the yearly increasing number of operations. There remain, however, a few questions which have been given relatively little, if any, attention in surgical literature, and to these I shall mainly devote this paper. It is perhaps unnecessary to give much time to discussion of methods of obtaining data as to end results; yet I may mention that living in a small community in frequent and close touch with people who are permanent residents gives often a somewhat different impression as to results than a single hurried examination or reply to a questionnaire. Our records show that of a total of two thousand and twelve cases operated upon by our present methods, approximately half come from Ithaca and a radius of 100 miles of surrounding territory. The condition of these patients is known not only by replies to a questionnaire, but in most cases by frequent personal examination, also by reports of friends and neighbors, and reports by patients' doctors. Many in all groups discussed in this paper and all in some groups have been examined personally. The importance of reporting progress is urged upon all patients during their stay in the hospital; it is also emphasized on the printed slip giving suggestions for after-care which is handed to patients on discharge, and a geographical card index of patients helps us to get reports from neighbors who come for treatment. Most of our patients are an intelligent class of people who coöperate satisfactorily in reporting end results and realize that it is frequently to their own benefit, as well as others similarly afflicted.

Pregnancy.—A number of times every year I am asked, "What would be the probable effect of pregnancy on the results of operation for goitre; would thyroid enlargement and the symptoms probably return as the result of pregnancy? Would the child show any physical or mental abnormalities as a result of thyroid lack in the mother? Would iodine, thyroid extract, or other medication be desirable during pregnancy?" The impression seems quite general that pregnancy generally does precipitate hyperthyroidism or induce permanent thyroid enlargement or both, but very little has been reported from the basis of actual clinical experience on this subject. I have reliable information as to the condition of twelve patients, pregnant at the time of, or subsequent to partial thyroidectomy; all have gone through their pregnancies to full term and all have given birth to healthy children. One

* Read before the American Surgical Association, April 17, 1924.

has given birth to three children; two have given birth to two children; eight have given birth to one child since operation: a total of fifteen children. These patients were operated upon from three to eleven years ago, and only one has required further surgery. This patient was first operated upon at the time when most of us were doing hemithyroidectomy because of fear of post-operative cachexia strumipriva. She had considerable enlargement of the left side at the time of the first operation, and returned because of further enlargement and pressure symptoms. A further partial thyroidectomy was done from which she has made a satisfactory permanent recovery, now four years past her final operation. Another patient, personally examined a few days before writing this paper, has a slight enlargement which does not warrant operation at this time. The remaining nine remained apparently entirely well. Five of the number originally had disfiguring or obstructive growths; three were toxic adenomatous goitres; one very toxic exophthalmic. Four were examined as to end results personally, one by an assistant, and four reported by letters. Of three patients who were pregnant at the time of operation; one was operated upon at three months because of obstructive symptoms; another was operated upon at seven months because of suppurative thyroiditis; attempts at relief by drainage without radical surgery were unavailing and most of an extensively infiltrated gland was removed with considerable difficulty; recovery was rapid in both cases and they remain well three and five years after operation. The third patient had a highly toxic exophthalmic goitre and elected partial thyroidectomy rather than abortion at five months; her pregnancy went to term and she gave birth to a healthy child, and has since safely gone through another pregnancy; both of her children are normal and she remains in good health eleven years after operation in spite of the somewhat trying conditions of the life of a Missionary in China.

So far as can be judged from so small a number of cases, the end results seem to justify the conclusion that thyroid surgery need have no evident effect on children born at a subsequent pregnancy; that there is not much tendency to return of symptoms or enlargement; and that operation during pregnancy is not particularly dangerous.

Menstruation.—As to menstrual function: there is complete cessation of periods for from three to six months or longer in practically all of the extremely toxic adenomatous and exophthalmic goitres which we see. In no instance under my observation has this been permanent and the return of menstruation occurs as soon as the patient is well on the road to recovery. At first most of the patients are greatly disturbed over the cessation of menstruation and inquiry as to probable outcome must come to almost everyone who sees many toxic goitres.

Profuse menstruation as the result of lack of normal thyroid secretion has not been reported to us in a single instance. The danger of myxœdematous changes as a result of thyroidectomy is probably greatly overestimated. Osler, who no doubt had under observation as large a number of patients as any consultant of his time in this country, in at least two editions of his text-book

stated that post-operative myxœdemata is very infrequent, that he had observed only two such cases, and that one of these cleared up under treatment. Probably surgical methods and results have greatly improved since this statement was made.

Exophthalmos.—My impressions as to ultimate results with exophthalmos have radically changed within a few years. The results as regards appearance of the eyes following operation upon patients with extreme exophthalmos are often discouraging even after four or five years have elapsed. As with other symptoms, the cases of long standing improve more slowly and less surely, but observation of late end results leads me to believe that in many cases exophthalmos continues to lessen, even long after the general physical condition has come back to normal. In thirty-nine cases examined by me or my assistants seven to fourteen years after operation, the eyes of thirty-one are normal, or so nearly so that they would not be noticeable to the average observer. All of these patients live near Ithaca and most of them have been seen frequently. Few of these extreme cases showed much improvement in the first three years and some retained noticeable exophthalmos for five years. While I formerly told patients with very prominent eyes that the prospect of improvement was doubtful, on the basis of observation of later end results, I now tell them that they have at least three chances out of four of ultimately getting fairly normal eyes.

Advanced Age.—What should be advised in the case of an aged person suffering seriously from goitre is often a difficult question. The distress caused in some of these cases is indicated by the fact that patients as old as eighty-six have come for consultation to consider surgical relief. Of course no sane surgeon advises operation for any condition with a patient advanced in years unless the indications seem urgent, hence, experience as to end results in older goitre patients is limited. The widespread impression both in and out of the profession that lack of thyroid secretion influences the development of senile changes has doubtless led most of us to be especially slow to meddle with the thyroids of older people. Yet, my own experience in operating upon thirty-one patients over sixty, who we have been able to follow, leads me to feel that possibly there is quite another side to the question. The indications for operation seemed definite in all of these cases: Nineteen had obstructive symptoms, eleven had adenomata with quite a high degree of toxæmia, and one was malignant. Of fifteen patients between sixty and sixty-five years of age, three have died; one from local recurrence of malignancy (small round-cell sarcoma); one from operation at another clinic for enlarged prostate; and one from apoplexy. The remaining twelve are living and well; eight of these patients are from five to eleven years past operation; one patient now seventy-one years of age is nine years past operation; one seventy-six years of age is eleven years past operation. Three patients were over sixty-five years of age at the time of operation; one of these patients died from unknown cause; one is living at sixty-nine years of age; one patient operated upon for serious obstructive symptoms when

seventy-two years of age was living at last report, with failing eyesight but otherwise well, over eighty years of age. Many of these patients looked thin, almost to emaciation; pale, gray, and even older than their years. Many of them looked ten years younger before leaving the hospital and all considered themselves greatly benefited. Is it not possible that the drive of an overactive thyroid for years causes rapid wearing out quite as frequently as thyroid lack precipitates senile changes?

Childhood and Adolescence.—The important influence of the thyroid in development, both physical and mental, rules out surgery in childhood and adolescence except in cases presenting urgent symptoms, but harmful results have not appeared in any of my patients operated upon when under twenty years of age. Twenty-eight cases are included in this group. Avoidance of unfortunate end results seem to me to be dependent upon leaving a fairly liberal strip of thyroid tissue with unimpaired blood supply from at least two of the four main arteries. Dr. W. S. Halsted's early work showed conclusively that dogs with a small amount of thyroid with normal blood supply at one pole are capable of hypertrophying the stump to supply the needs of the animal.

The strip saved should be along the posterior surface of the gland over the great vessel sheath and along the trachea and larynx in order to avoid injuring the parathyroids and the recurrent nerves. With this precaution none of my younger patients have developed any evidence of thyroid or parathyroid lack. The youngest patient was a little girl operated upon at three and one-half years of age because of serious symptoms of obstruction in breathing. She made a perfectly satisfactory recovery and at last report was well eight years following operation. A girl of fourteen years of age operated upon because of an extremely toxic exophthalmic goitre has remained entirely well fourteen years since operation, the longest of any of my children patients. She had developed from a child into a very attractive young woman, has taken an Art Course with credit, and is now a successful illustrator, is married and remains entirely well.

Glycosuria.—Approximately 5 per cent. of all toxic goitre patients coming under my care have a trace of sugar in the urine. In all cases these small traces have cleared up with attention to diet and recently occasional use of insulin, while the patients have been in the hospital, and the end results three to fifteen years after operation show no evidence of trouble from this source. There are fifty-three patients in this group. On the other hand, patients with high percentages of sugar in the urine and high blood sugar associated with toxic goitre usually do badly. Three such patients have died without any surgery within a week of admission to the hospital, in spite of the best medical care available. Three have been sent back to their home physician. Another three, exactly $33\frac{1}{3}$ per cent. in my limited experience, have been brought sugar free under medical care, have had preliminary ligations followed by later excision and remain well without very strict medical supervision, although they are requested to report regularly for urinalysis and occasionally blood sugar

estimation. To summarize my own experience: the lower percentages of sugar have cleared up before operation, remaining permanently free after operation without special attention to diet or medication: in case of high percentages of sugar, associated with toxic goitre, two-thirds of the patients die without operation; while when higher percentages are cleared up by diet, insulin or a combination of the two sufficiently to warrant operation the patients do well, requiring little medical attention to keep them sugar free.

High Blood Pressure.—Several writers on blood pressure state that the administration of thyroid extract usually causes a fall in blood pressure, although in certain instances blood pressure is increased. This belief that thyroid secretion usually lowers blood pressure has probably led to the assumption that removal of goitre would have an unfavorable influence on high blood pressure, for of course a certain amount of normal thyroid tissue is removed, even with large adenomatous and colloid goitres. As a matter of experience, dangerously high blood pressures are frequently favorably influenced by thyroidectomy. Until recently I have not operated upon patients with very high blood pressures, hence the end results do not date back in most of my cases more than to five years. Patients with blood pressures over 180 are invariably given preliminary treatment, rest in bed, low protein, salt-free diet, and free purgation. In the case of patients with pressure above 200 systolic, we have not operated unless it was possible under treatment to reduce the pressure to 190 or lower. In eleven cases with pressure above 200 systolic, there has been such immediate and striking improvement after thyroidectomy, that it seems fair to attribute the patient's improvement to operation. In one instance the blood pressure dropped immediately from 200 to 150 and later was reported by the patient's home physician at 120; in another instance the drop was from 220 to 140; a third patient dropped almost immediately following thyroidectomy from 240 to 150, and still further improvement has been reported since this patient returned to her home. The less encouraging side of the question is that two patients have died from apoplexy within a few months after leaving the hospital and in the remaining twenty patients the improvement has not been greater than would be expected from such restriction of diet and general care as it has been possible to enforce. Thus far, we have been unable to discover any criterion enabling us to select those patients with high blood pressure who would be benefited from those in whom no improvement could be expected. There has been unquestionably a very striking immediate, and thus far permanent, improvement in 30 per cent. of the high blood pressure cases. If a three years' period may be considered an end result, the end results are good in this proportion of my cases. It seems to me that this condition is deserving of careful study by laboratory as well as clinical workers.

These are but a few of many unsettled problems which must come to anyone seeing considerable numbers of goitre patients. The wide experience of many members of this Association should add much toward their solution.

END RESULTS OF GOITRE OPERATIONS*

BY ALBERT J. OCHSNER, M.D.

OF CHICAGO, ILL.

THE following plan was carried out in order to determine, as nearly as possible, a fair idea of end results in this type of cases. A questionnaire containing the following inquiries was sent to the addresses of 1200 patients upon whom Dr. N. M. Percy and I had operated at the Augustana Hospital for exophthalmic and toxic goitres during ten years, ending January 1, 1923, so that none of the answers included came from patients operated upon less than fifteen months ago:

1. Have you been well since returning home from the hospital?
2. How long were you weak after returning home from the hospital?
3. Have you followed directions on diet list?
4. Have you continued drinking boiled or distilled water?
5. Have you any disturbance of the heart?
6. Have you gained in weight?
7. Have you had any new complaints since leaving the hospital?
8. Please give a general description on space below of how your health has been since leaving the hospital?

The following table gives an analysis made by our colleague, Dr. O. E. Nadeau, of the answers received from the first 500 patients who sent in their reports. Later the remaining answers will also be analyzed. It seemed sufficient for the present paper to analyze this number:

ANALYSIS OF 500 REPLIES TO QUESTIONNAIRES IN CASES OF TOXIC
AND EXOPHTHALMIC GOITRE

Ages	Cases	Duration of weakness after operation	
		Months	Years
11-20	48—9.6%	1 month or less	1..... 42
21-30	129—25.8%	2 months	96 2..... 24
31-40	123—24.6%	3 months	69 3..... 3
41-50	105—21.0%	4 months	27 4..... 3
51-60	73—14.6%	5 months	12 5..... 1
61-70	19—3.8%	6 months	36 6..... 2
71-80	3—0.6%	7 months	7 7..... 0
		8 months	3 8..... 1
		9 months	2 9..... 1
		No mention	17

Symptoms recurred after operation similar to some of those experienced before operation—119.

Those who followed directions constantly 278, but symptoms recurred in 73.

Those who did not follow directions constantly 207, but symptoms recurred in 41.

Those who drank boiled water constantly 154, and symptoms recurred in 38.

* Read before the American Surgical Association, April 17, 1924.

END RESULTS OF GOITRE OPERATIONS

Those who did not boil water constantly 337, and symptoms recurred in 77.

Those who had recurrent symptoms but did not mention diet 5.

Those who had recurrent symptoms but did not mention water 4.

Disturbances of heart. Yes—125; no—357. No mention—18.

Voice affected temporarily 5, permanently 1. Recurrent tumor of neck, 35. Persistent exophthalmos, 44. Worse after operation, 8.

Deaths.—2 months—1; 7 months—1; 9 months—1; 2 years—2. Of these 1 died of carcinoma of the stomach. 3 years—3. Of these 1 died a suicide from melancholy. 4 years—1. Of these 1 died of diabetes. 5 years—1. Cause not mentioned. 6 years—1, who died of diabetes. 9 years—1. Cause not mentioned.

Patients who stated they felt better when following strict directions—21.

Unusual Complications.—One case has unilateral exophthalmos (dextra) six years after operation. Two cases (male) developed insanity one and one-half years after operation.

It will be seen that 70 per cent. of our cases were between the ages of twenty and fifty years, and that 64 per cent. had regained approximately normal strength within three months following the operation, while 15 per cent. remained weak for more than one year.

In 24 per cent. some of the symptoms present before the operation had either persisted, or they had recurred, since the operation, but with the exception of the twenty-one cases noted specially below, eight of whom were worse and three who died within one year following operation, all of this group of patients were better in some respects than they had been before the operation, although none of them were well.

During this period of ten years we have given each patient the following printed list of directions upon leaving the hospital with the hope of improving the prognosis:

1. Avoid excitement or irritation of every kind. If anything happens to annoy you, put it off for a week. Never do anything in a hurry or long enough to become really tired.
2. You should get an abundance of rest, by going to bed early, not later than 9 P.M., and taking a nap after luncheon.
3. You should get an abundance of fresh air, especially at night, consequently you should sleep with wide open windows, or on a sleeping porch.
4. You should drink nothing that irritates the nervous system, like tea, coffee or alcohol. Of course you should not use tobacco in any form.
5. You should eat very little meat. If you are very fond of meat, take a little beef, mutton or breast of chicken or fresh fish once or twice a week, or at most, three times a week.
6. You should drink a great deal of milk, or eat things that are prepared with milk, such as milk soup, milk toast, etc. Cream and butter-milk and Horlick's malted milk are especially good for you.
7. You should avoid beef soup or beef tea or any kind of meat broths.
8. You should eat an abundance of cooked fruits and cooked vegetables of every kind, or very ripe raw fruits, or drink fruit juices prepared out of ripe fruits.
9. You may eat eggs, bread, butter, toast, rice, cereals.
10. You should drink an abundance of water boiled for twenty minutes, distilled water may be used in place of boiled water. Do not drink unboiled water.

The table shows that the majority of these patients have not followed these directions constantly since leaving the hospital and that there was practically no difference in the percentage of complete cures between those who did and those who did not follow these directions, except that twenty-one patients stated definitely that they felt better when they followed the directions strictly.

Twenty-five per cent. of our patients still suffer to some extent from tachycardia, or some other form of cardiac disturbance.

Five patients, or 1 per cent., had some disturbance of the voice for a time, which has, however, completely disappeared, while in one patient it has persisted to some extent.

There was a recurrence of the goitre in 7 per cent. of the cases, and all of these had returned to their former mode of living, including the drinking of unboiled water.

Exophthalmos persisted in 9 per cent. of the cases. In one case a right-sided unilateral exophthalmos has persisted for six years. Three cases died within one year after the operation. Twelve died from two to nine years after the operation from diseases not connected with their goitres. Aside from these only eight cases, 1.6 per cent. of all cases, were worse after the operation than before.

It has been possible to make a personal examination of only a proportion of these patients in order to compare their present condition with the records of their pre-operative condition, which would, of course, be necessary to make a report of end-results satisfactory. All of the cases that I had an opportunity to examine personally showed a marked improvement over their pre-operative condition even in case of the presence of some unfavorable symptoms, but this may have been simple coincidence, and may not hold true for those not personally examined.

REPORT OF THE RESULTS OF OPERATION ON A GROUP OF 150 CASES OF GOITRE*

BY CHARLES N. DOWD, M.D.
OF NEW YORK, N.Y.

THE effort of the Executive Committee of the American Surgical Association, to promote late reports on the results of treatment for goitre, is surely a commendable one. There is hardly a subject which is more written about in surgical literature, than goitre; and the effort to solve the goitre problem is attracting the energies of a very large number of competent men; but in proportion to this great activity, there has been too little attention to the late results of the different forms of treatment.

Wishing to add a little to the subject, I have endeavored to study the later condition of 150 patients, on whom I have personally operated for goitre between 1899 and 1924. The report is confined to personal cases, because they give better opportunities for study than we are able to obtain from groups which represent the work of several surgeons on a Hospital Division. They represent all the patients on whom the writer has operated for goitre during this period.

In addition to these cases many others have been treated by medication or rest or hygienic regime or by X-ray. Most of them have passed out of observation but have shown certain peculiarities which are referred to in the text.

The types of goitre have varied from acute hyperplastic goitres of overwhelming toxicity to encapsulated cysts with little or no toxicity. Toxic adenomata, however, were more common than any other type.

There were also two cases of cancer which are not included in the list, because only diagnostic incisions were made.

All but five of the patients have been traced since leaving the hospital. The periods of observation are indicated in the following table:

Followed into 21st yr. 1 patient	Into 9th yr. 9 patients
Followed into 20th yr. 1 patient	Into 8th yr. 13 patients
Followed into 17th yr. 1 patient	Into 7th yr. 8 patients
Followed into 16th yr. 2 patients	Into 6th yr. 13 patients
Followed into 15th yr. 4 patients	Into 5th yr. 17 patients
Followed into 13th yr. 2 patients	Into 4th yr. 14 patients
Followed into 12th yr. 4 patients	Into 3rd yr. 17 patients
Followed into 11th yr. 3 patients	Into 2nd yr. 16 patients
Followed into 10th yr. 7 patients	Into 1st yr. 8 patients

The reports have been made by the writer from personal observation in 83 instances; by another physician 11 times; by the patient either by letter or telephone conversation with the writer 26 times; by a nurse 6 times; by the patient's relative or friend 14 times.

* Read before the American Surgical Association, April 17, 1924.

Kinds of Operations.—The operations have been done primarily with the view to adjusting the operative procedure to the patient's strength, but with the ultimate purpose of removing as much of the thyroid gland as the patient could spare without endangering the normal thyroid function. In most instances, four-fifths of one lobe and from one-third to three-fourths of the other lobe have been removed. A primary ligation of one or both superior thyroid arteries has been done in twelve instances. Usually this has been followed by the removal of a large portion of the enlarged gland. Occasionally no further operation than the ligation has been practicable or even desirable. As the work has progressed, it has been possible to gauge the patient's strength in such a way as to keep within fairly safe limits in the selection of operative procedure.

"Standards for Estimating Results."—In estimating the results of these operations, we have based the reports on the ability of the patient to perform the ordinary duties of life. We believe that this is the most important standard. The patients who come to us with goitre wish to be cured of their disabilities, so as to have at least the ordinary capacity for work and enjoyment. A result short of this is not satisfactory, no matter what the pulse-rate, or basal metabolism or bodily weight. If, however, these patients are able to carry on the ordinary duties and pleasures of life in comfort and health, the results may be considered satisfactory.

It is important to have a mental picture of the entire group of patients; thus endeavoring to show what may be expected of such people after their operations.

We have, therefore, classified them into five divisions:

1. Operative fatalities.
2. Patients who have died either of intercurrent disease or from results of goitre since leaving the hospital.
3. Patients who are definite invalids.
4. Patients who are able to do a moderate amount of work and to enjoy life but habitually have to guard against over-exertion.
5. Patients who really enjoy life and have at least the average capacity for work or other activities.

Fortunately, the latter group preponderates in a large majority. If we consider those patients who have been observed since leaving the hospital, 73.6 per cent. belong to this group. An additional 22.8 per cent. are grouped with those who can enjoy and do a moderate amount of work but have to guard against over-exertion.

In order to explain these divisions, we may refer to some of the patients in detail.

Division 1.—*Operative fatalities*—five patients. The first three had advanced Graves' disease in its extreme form. Their ages were, respectively, twenty-three, twenty-six, and sixteen years. They had exophthalmus, palpitation, sweating, extreme nervousness and very rapid hearts. One of them died on the table before even a ligation could be completed. Another died

three days after operation with œdema of the lungs and the other on the third day after operation, having "rusty" sputum and signs of pneumonia.

In view of subsequent experience, operation would not have been attempted on these patients in the conditions which they then showed. These three fatalities occurred among the first thirty-three cases. It is possible that a preliminary ligation of a single superior thyroid artery at a properly selected time without even removing the patient from bed, might have been successfully done for one or all of them and that further procedure could have been accomplished later.

It is to be noted that in the next 117 cases there were only two deaths. One of them a girl of twenty-three, who had suffered from hyperplastic goitre for several years and had undergone several operations, died after an effort to remove a part of the remaining left lobe of the gland. The other was a patient who beside her goitre had mitral regurgitation and a dilated heart. She was kept in the hospital for twenty days before operation, and although her heart lesion was well understood, the operation seemed advisable. She went through the operative procedure without incident. Her pulse was about 90 throughout the operation and she seemed to do well until the evening of that day, when she suddenly died. The physician who observed her at that time thought that her death was due to a coronary embolus. Every surgeon who is not excessively timid has to take an occasional risk of this sort. When, however, we consider that there were 117 consecutive cases with only these two deaths, we may appreciate that we are dealing with a very low operative mortality.

In considering this group of fatalities, we are impressed with the deadly character of the disease in the first four of these patients and our great regret is that their thyroids could not have been attacked before their hyperplasia had led to such serious symptoms.

Division 2.—*Patients who have died since leaving the hospital*, either from progress of the *goitre* or *from intercurrent disease*. Four patients: One thirty-three years of age, who had suffered from goitre for seven years, and who had reached the stage of degeneration of her internal organs. She was kept in the hospital for 29 days, resting in bed and having symptomatic medical treatment. Her basal metabolism varied between 64 and 39. The superior thyroids were then ligated without incident; one at a time, under local anæsthesia, in her bed. She improved considerably but insisted on going home. She died a month later in another hospital from so-called "heart disease."

The second case was a girl of nineteen years, with a moderate-sized goitre, exophthalmus, basal metabolism plus 37 and hereditary syphilis. Her two superior thyroids were ligated and she improved satisfactorily so that at one time I was willing to undertake subtotal thyroidectomy. Her guardians, however, refused this and she went from the hospital. She was under X-ray treatment for more than a year. She finally died with apparent degeneration of her internal organs.

The third case died about a year after leaving the hospital, from "cerebro-spinal meningitis." Her physician stated that she did not then give signs of hyperthyroidism.

The fourth case had both superior thyroids ligated in March, 1917. No further operation was done at that time. She was then extremely toxic. She existed for several years in a condition of invalidism, going from one hospital to another, having long treatments of X-ray, etc. In February, 1924, an effort at operation was made in another hospital and she died immediately following the operation.

It should be noted that ligation of the superior thyroid arteries was successfully accomplished for three of these patients and that they then either would not or could not have further surgical procedure and that the disease progressed in each instance. The fourth apparently died of disease not associated with her goitre.

Division 3.—*Patients of the Invalid Class.* I find only one patient in this group. He, too, refused further operation after his superior thyroid arteries had been successfully ligated. He is a man of twenty-six, who was first seen six years ago, having then had his goitre for three years. He had exophthalmus, tremor, weakness, extreme "nervousness," sweating and rapid pulse. Both superior thyroid arteries were ligated. Improvement followed, but he refused further operation. He tried to work as a clerk, but was unable to continue. In February, 1920, the right inferior thyroid artery was ligated by another surgeon. He then made another unsuccessful effort at light work. He was in another hospital for six weeks in 1921. He was seen in February, 1922, and was then weak and suffering from sweating, dilated heart, palpitation, tremor, and his neck was $16\frac{1}{2}$ inches in circumference. He was then three months in another hospital and had twelve X-ray treatments, improvement followed. He then tried again to do clerical work, but when seen by his physician, March, 1924, had been unable to continue even light work. It is hardly fair to consider him a case of operation. He let his opportunity pass when he refused partial thyroidectomy after his preliminary ligations.

Division 3.—*Patients who are able to do moderate amount of work and enjoy life but have to guard against over-exertion.* There were 32 patients in this group. They were all definitely better than before their operations. Several of them were better than we could fairly expect. Three cases may be cited for illustration, although others in the group were much stronger than these were. A woman of thirty showed marked invalidism from the ordinary symptoms of toxic goitre. After subtotal thyroidectomy and a period of rest in the hospital she regained her health and seemed to be normal for nearly four years. She then suffered from a post-partem hemorrhage. During the following two years her strength has only been moderate, but she has been able to carry on the ordinary duties of life. Another patient twenty-eight years old with severe Graves' disease had her superior thyroid arteries ligated separately under local anæsthesia in 1912 with an interval of seven days between the two ligations. This was followed four months later by

hemithyroidectomy. During the following six years she was not able to do much. During this period her disability was increased by family sorrow. She then gained strength and during the intervening years has been able to support herself and help care for her mother.

Another patient, forty years old, made an excellent recovery and was able to return to usual family and social activities. There followed a period of stress owing to misfortune in the family and corresponding period of depression and limitation of capabilities. Now for three years she has been reasonably active and carefree.

These cases represent the least capable part of the group. Without the operation, I believe that most of them would have collapsed under their trials or would have been useless invalids.

Division 5.—*The group of patients who really enjoy life and have at least the average capacity for work or other activities.* This is by far the largest group, representing, as before stated, 73 per cent. of the patients who were traced after leaving the hospital, or 68 per cent. of the entire series, including untraced and fatal cases. Many of them have much more than the average capacity for exertion. For instance, case No. 94 announced that "before operation" she could not climb stairs or raise her arm high without distress or "do much of anything," but that now at the age of forty-nine, five years after operation, she can do more than she had ever been able to do before, attending to her own house work and taking part in various activities. Case No. 59 reported eight years after her operation that she is caring for four children and husband, a big house and garden, and stated with much pride that on the day before she had washed twenty-two windows. Her goitre was large and contained an unusual combination of soft cellular and firm fibrous material.

Case No. 58 has carried on a life of unusual intellectual activity as a writer during the eight years which have elapsed since her operation, although she has suffered from a broken hip with its necessary confinement during that period. Her operation was for cystic adenoma of fifteen years' duration and two years' rapid growth. At the time of her operation her pulse was 120 and she suffered from palpitation, tremor and perspiration.

Case No. 12, fifteen years after an operation, "tends store all day, beginning at 6.30 A.M., and does the house work for herself and mother before and after these duties." Her operation was for a very large adenoma of fifteen years' duration and two years' rapid growth, severe pressure symptoms and moderate constitutional disturbance.

These facts are given in detail in an effort to show to others the impression which we have received on studying these patients. This group has impressed the writer as showing more than the average degree of good health and capability. All of them were incapacitated before operation—most of them from "toxic" symptoms—a few of them from pressure symptoms. Their study indicates a remarkable average of good health after previous disabilities which had been disturbing in a high degree.

It should be stated that in no instance has operation been done for the simple goitre of adolescence or for any other form of simple goitre which did not give definitely disturbing symptoms.

Of late much attention has been given to the query as to how patients with goitre will do without operation or even without treatment.

The histories of some of the patients mentioned in Groups 1, 2 and 3 indicate the condition to which such patients may drift. Two other experiences which throw light on the subject also come to mind. One, a woman of fifty-eight, who had had a goitre for thirty years. Her pulse had frequently been rapid and she had frequently been obliged to stop her labors at housework, but she would always resume them again as soon as the acute attack had passed away. When I saw her she had acute pain in the epigastrium. Her heart was dilated, very irregular and gave beats from 160 to 180 per minute. It was of extremely poor quality and made any operative procedure out of the question. She was very thin and had a large goitre most marked on the right side of her neck and apparently cystic there. This was an example of chronic goitre which had finally resulted in cardiac failure. She died on the following day. The other, a man of forty years, who had lived in the Middle West and had been suffering from the symptoms of acute thyroid disease for three months. He had lost 20 pounds, was weak and had to give up work. He had a severe tremor and rapid pulse and was very nervous. His goitre was soft and of moderate size. He was taken to the hospital for a more thorough examination, but became restless after two days and returned home. His weakness then increased and he died within a few days. All surgeons who see many goitres have similar experiences and are forcibly impressed with the seriousness of the disease in both its chronic and acute forms.

When such cases are contrasted with the results which have followed the operations in this group, one must feel like attacking the disease in a radical manner.

Cancer or Suspected Cancer.—The pathology of the thyroid is complex. It brings puzzling problems to both pathologists and clinicians. The most remarkable instance in this group occurred in a man of forty-eight, who for a year had suffered from a left-sided goitre, with both constitutional and pressure symptoms. An encapsulated cystic tumor 9 x 7 x 5 cms. in its diameters was enucleated from the left lobe of the thyroid. None of the adjoining tissue was removed. Since there was no apparent extension of the growth beyond its capsule and since its enucleation was easy, malignancy was not clinically thought of. However, three well-known pathologists agree in the diagnosis of "adenocarcinoma, probably of low malignancy." At the present time, three and one-fourth years after the operation, the patient is free from recurrence and is enjoying excellent health. Another patient who had a papillary cyst adenoma has now been followed for nine years. He is entirely free from symptoms and is actively engaged in business. He had rapid recurrences after his first partial operations and finally every discoverable bit

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of thyroid gland was removed and radium was left in the wound for a few hours, in the endeavor to control any fragment which might possibly remain. There was also much pathological and clinical consultation about this case and bad prognoses were generally given. There were two other papillary cyst adenomas in the group, but there was no recurrence or suggestion of malignancy in either of them. Another tumor which clinically suggested a progressing neoplasm was reported "lympho-granuloma of thyroid." The patient made an excellent recovery after its removal, and now in her fifth post-operative year shows no suggestion of recurrence. These cases are mentioned to show the uncertainties of thyroid pathology.

The relationship of the X-ray to the thyroid gland should also be considered. A number of cases here recorded had received X-ray treatment before coming for surgery. It is not now possible to say how many. Some of the cases mentioned in Divisions 2 and 3, also received X-ray treatment after leaving the hospital. I have treated at least four patients by X-ray without operation. Two of them were very mild cases and have done well. A third case was toxic; when first treated had a marked tremor, basal metabolism plus 35, with a very small thyroid. He did well under X-ray. Another one with a large adenoma and very mild toxic symptoms preferred X-ray treatment to operation and now after the lapse of a year is in about the same condition as when first seen.

It is notable that experienced röntgenologists consider hyperplastic thyroids the most suitable type for X-ray treatment and that many failures of relief come after X-ray treatment of such goitres, also it is notable that adenomata which are not so well suited for X-ray treatment produce some of the most disturbing symptoms and respond particularly well to surgery.

The results of ligation of the thyroid arteries have been interesting. Preliminary ligation of the superior poles of the thyroid gland, including the arteries, has been a common procedure in patients too ill for more extensive primary operation. Definite improvement almost always follows this procedure, so that after two or three months a suitable portion of the gland may be removed. These patients, however, are not always easily controlled and sometimes cannot be persuaded to submit to the secondary operation. Cases already quoted in groups 1 and 2 show the unfortunate condition into which such patients may drift. One patient, however, did so well after double superior pole ligation that secondary operation was not advised; and now, after the lapse of eleven years, is in excellent condition. She was a young woman of twenty-four with a short history of acute hyperthyroidism.

There are two notable results following quadruple ligation, one a patient of thirty-eight years had severe toxic symptom of five months' duration. She had a rather large symmetrical goitre, exophthalmus, tremor, pulse 120 to 150, and was too weak to work. The superior arteries were ligated in June, 1919, and the inferior arteries in February, 1920—she made a remarkable recovery and has now been working successfully as laundress for more than three years. Another young woman whose symptoms were complex, but who

had exophthalmus—moderate-sized goitre, rapid pulse, “nervousness,” inability to work and basal metabolism plus 17, recovered her poise after quadruple ligation and at the present time, three years after her first ligation, is successfully conducting a boarding house.

Operation on patients under the age of twenty-one is not often desirable. The goitre of adolescence frequently subsides without operation. There are two rare exceptions to this rule: first, the young patient who develops extremely toxic symptoms—“true exophthalmic goitre”; second, the young person who develops an adenoma so large as to give pressure symptoms or real disfigurement. An instance of the latter condition may be referred to. Case No. 16 came to me in 1909 when twenty years of age, having a goitre which had been present twelve years. It was very large and was giving great disfigurement and some pressure symptoms. I removed a large part of it and found it to be an adenoma with cystic formation in some parts. On seeing her fourteen years later, I find her in excellent health. She has had seven children in the meantime and her goitre has returned. Her neck is now the site of a large cystic goitre which is similar to the one which was removed fourteen years ago. However, it is soft and does not give pressure symptoms.

There have been a few other adenomas in young girls which have developed to considerable size and have given definite pressure symptoms. These have been removed with good results.

The seriousness of long persisting adenomas and the favorable result of operation may be illustrated by the following case: A patient of forty-five years, with a moderate-sized goitre, came to the hospital with a six-year history of disability, having had remissions and exacerbations, but having endeavored to carry on her ordinary duties during most of the period. She has recently shown lack of strength, tachycardia, tremor, nervousness, perspiration, and was unable to work. On admission to the hospital her disability was extreme. Perspiration and weakness and nervousness were excessive. Basal metabolism was +83. She manifestly was not in condition for surgical procedure. She went to an endowed room in the Medical Division for five weeks where Doctor Sumner kindly attended to her treatment. She showed considerable improvement, her basal metabolism went down to +30 and then went to +40. Her heart was dilated and rapid and irregular, pulse being 110 to 120. She gave definite evidence of degeneration of the cardiac muscle. However, since the thyroid nodule was apparently encapsulated and since she had ceased to improve under medical treatment, I removed the nodule by a very short operation and she made a remarkably satisfactory recovery, pulse coming down to 64, basal metabolism reaching normal and her entire mental attitude being satisfactory. Her strength improved and she was able to return to her ordinary duties.

Recurrences.—In one instance (just referred to) there has been a recurrence of an adenoma which has reached a large size. In seven other instances there have been moderate recurrences of adenomas, none of them serious.

Hypothyroidism has not been observed in any of the patients.

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SUMMARY

1. The results of treatment on these 150 patients may be tabulated as follows:

	Number of patients	Percentage of those patients who were traced after leaving hospital	Percentage of entire group
a. Enjoying good health and able to do at least the ordinary amount of work	103	73.6	68.66
b. Able to enjoy life and do moderate work but carefully avoiding over-exertion	32	22.8	21.33
c. Persistent invalidism	1	0.7	.66
d. Died since leaving hospital	4	2.9	2.66
e. Died in hospital	5		3.33
f. Not traced	5		3.33
Total	150		

2. The operations have been adjusted to meet the strength of the patient, sometimes beginning with the ligation of a single thyroid artery and progressing in stages to the removal of three-quarters or more of the enlarged gland.

3. Acute hyperplastic thyroids have given the most severe symptoms but toxic adenomas have sometimes been almost as serious.

4. Adenomas and so-called colloid goitres have sometimes given distressing symptoms from pressure and unsightliness.

5. Some patients have improved under rest and medicinal treatment and the use of the X-ray, but so many failures have been noted in these forms of treatment that operation is believed to be the best form of treatment for a very large proportion of patients with goitre.

6. The pathology of cancer and growths which resemble cancer is very complex.

A REPORT OF 87 PRIMARY OPERABLE CASES OF CARCINOMA
OF THE BREAST ADMITTED TO THE NEW YORK
HOSPITAL PRIOR TO APRIL 1, 1919

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AND

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THE literature of mammary cancer contains many reports of high percentages of good end results, in the surgical treatment of this disease. A careful scrutiny of these records sometimes reveals the fact that many recent cases are included, making a proper estimate of the operative results difficult and at times impossible. The object of this paper is to place on record the late results in a series of cases of carcinoma of the breast operated at the New York Hospital,† prior to April 1, 1919, five years or more ago. All cases of more recent date are excluded from consideration. A still more dependable period for end results is seven or ten years, but sufficient cases are not available to make a report upon this basis. We appreciate that the group is a small one, but we feel that a critical analysis of these cases may furnish some valuable conclusions.

At the very outset we wish to place ourselves on record as objecting to the continued use of the term "three-year cure," the basis of our objection being twofold. First, any serious consideration of results in the treatment of breast cancer at the end of three years is ill-advised, for the three-year limit gives a poor impression of what the end result will be. Second, we desire to protest against the continued use of the term "cured," in recording the results of the treatment of this disease by any means. We are all familiar with the occasional cases of late recurrence, occurring many years after the surgical treatment of carcinoma of the breast, and therefore we believe that the word "cured" should be abandoned and replaced by the phrase "no evidence of disease to date."

Our study embraces only primary cases which were presumably operable and were subjected to surgery in the hope of eradicating the disease. In general, the criteria of operability were a tumor in the breast, not fixed to the chest wall, with or without involved axillary nodes. The presence of supraclavicular nodes placed the case in the inoperable group, and no patient was subjected to a supraclavicular dissection. This judgment concerning the

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† The writers gratefully acknowledge the privilege accorded them by Dr. Chas. L. Gibson and Dr. Eugene H. Pool, of recording the cases of mammary cancer from the First and Second Surgical Divisions of the Hospital. They also appreciate similar courtesies extended by other surgeons on these Services.

involvement of supraclavicular nodes is concurred in by Peck and Sutton and Rodman and Greenough have stated that no satisfactory end result has been attained where supraclavicular nodes were involved at the time of operation. We are so convinced that supraclavicular metastasis is an expression of a considerable dissemination of the disease, that to-day we call cases inoperable that show definite and well-marked supraclavicular fulness, even though no palpable nodes are present. Experience has taught us that such cases invariably develop nodes which are palpable a few weeks or months later. The criteria of operability of mammary carcinoma are changing, and cases to-day are subjected to a much more careful scrutiny than was the case ten years ago. Therefore, it is probable that some of the patients included in this report and treated as primary operable carcinomas of the breast might to-day be placed in the inoperable class. The writers feel that the presence of axillary nodes, which are obviously extensively involved, reaching well up to the clav-



FIG. 1.—Rapid metastasis after operation for mammary carcinoma associated with seven months' pregnancy.

icle, or which are fixed to the chest wall, indicates inoperability. Further, a more searching study of a case with special regard to the paths and symptoms of distant metastases, especially to the chest and bones, will sometimes reveal evidence eliminating the patient from the operable class. A summary of the factors placing a case in the inoperable group has been indicated in a recent communication of one of the writers. We have not included in this study any of the primary inoperable or recurrent cases admitted to the hospital in the period mentioned, as we believe they must be considered separately. Further, the end results in these groups have no relation to the problem of the treatment of primary operable mammary cancer by surgery.

If one weaves his way through the mass of literature upon this subject, he will find a varied series of figures of so-called "cures," in percentages varying from 22 per cent. to 46 per cent. As one studies these statistics,

he is forced to the conclusion that many factors must be considered in evaluating the reported results. These factors are:

1. The pathological diagnosis of carcinoma may vary widely in different clinics. If one includes in his carcinoma series border line cases of epithelial growth (so-called pre-cancerous lesions), the figures for good end results will be raised to a very high percentage. As far back as 1907, Halsted pointed out that some pathologists might include "a few epithelial cells here and there escaping into the stroma as carcinoma." Are the cases of so-called "microscopic cancer," which Rodman says he finds in 23 per cent. of the cases of

chronic cystic mastitis, to be included in reports of end results of the treatment of mammary cancer? We feel that the surgeon is too prone to accept as truth typewritten pathological reports made by pathologists, some of whom may lack the highest technical training. One of the writers has received pathological reports from one New York hospital upon five breast cases showing definite recurrent phases of mammary cancer, the report in all five instances being incorrectly rendered "fibroadenoma."

2. Many writers apparently include a certain



FIG. 2 —Radiograph of early chest metastasis.

proportion of recent cases which swells percentage figures. We have found it difficult to separate out the results in recent cases from those operated five years or more ago.

3. Many of the cases have not been completely followed up. Until the last decade, adequate follow-up systems were not a part of any hospital organization, and vast numbers of cases operated upon for this disease were completely lost track of. Therefore, it was quite impossible for most surgeons to evaluate the real end results in the surgical treatment of cancer of the breast.

4. In many reports a large number of cases are excluded which have been lost sight of, many of whom are probably dead.

The present paper is a study of eighty-seven presumably primary operable

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cases, seventy-five of whom have been followed through sufficiently to furnish accurate data concerning the five-year results obtained. Of the seventy-five cases, the following tabulation is made:

Results to Date in 75 Primary Operable Carcinomas of the Breast

Alive and with no evidence of recurrence	10
Died without recurrence more than 5 years after operation	1
Died with recurrence	54
Recurrence, but not completely traced	10
	—
	75

Following on p. 404 is a detailed list of the 75 patients.

Twelve cases are excluded from major consideration because of inconclusive data as to end results, but these patients are separately studied in conjunction with the 75 complete cases in tabulating certain etiological data. These 12 patients group themselves into two classes: namely, those dying before five years had elapsed without recurrence, but from intercurrent disease, and secondly, those which were impossible to trace, although not recurrent when last observed. A brief tabulation of these twelve cases is appended.

A study of the 87 cases yields certain facts concerning the influence of trauma, previous abscess in the breast and prior lactation, in connection with the etiology of mammary cancer.

Trauma.—Of the entire 87 cases a positive or negative statement concerning a definite history of trauma was made by 55 patients. In each instance a positive statement by the patient was considered reasonably reliable evidence.

Trauma as an Etiological Factor.—Positive 15, 27 per cent.; negative 40, 73 per cent.

The traumatizing agent varied from blows or falls upon the breast to corset pressure, and one patient made the statement that she had been accustomed for years to stick pins into the portion of the breast which subsequently became the seat of cancerous disease.

Types of Trauma.—Blow or fall upon breast, 11; corset pressure, 2; bullet wound, 1; habit of sticking pins in breast, 1. Total, 15.

Previous Abscess of the Breast.—Five cases had previously suffered from abscess of the breast. There seems little question that the damage done to mammary tissue in the presence of a suppurative process furnishes favorable soil for the development of carcinoma.

Prior Lactation.—We are more and more impressed with the frequency of occurrence of cancer in breasts that have never lactated. In this series no statement concerning previous lactation was made in 15 instances. Of the remaining 72 patients, exactly one-half had a history of previous lactation. It seems reasonable to conclude that prior lactation is not an important factor in the development of mammary cancer. Positive 36, 50 per cent.; negative 36, 50 per cent.

Situation of the Tumor.—In 81 cases, the record shows that the left breast was involved in 43 instances and the right breast in 38.

TABLE I

No.	Surgeon	Year	Name	Age	Duration Before Operation	Duration After Operation	Total duration	Result	Pathology	Date metastasis	Metastasis
1	Hitzrot.....	1912	S.	45	2 yrs.	2½ yrs.	4 yrs., 6 mos.	Died	Scirrhus	6 mos.	Opp. breast, spine.
2	Lee.....	1913	C.	26	5 mos.	11 mos.	1 yr., 4 mos.	Died	Duct ca.	4 mos.	Opp. breast chest, supra axilla.
3	Lee.....	1913	H.	50	6 mos.	3 mos.	9 mos.	Died	Scirrhus	3 mos.	Spine.
4	Gibson.....	1913	L.	34	8 mos.	5 mos.	1 yr., 1 mo.	Died	Ca. very malignant	2 mos.	?
5	Gibson.....	1913	M.	52	7 mos.	2 yrs., 8 mos.	3 yrs., 3 mos.	Died	Scirrhus	?	?
6	Gibson.....	1913	V.	58	1 yr.	10 yrs., 5 mos.	11 yrs., 5 mos.	A. W.*	Scirrhus	.....	.....
7	Lee.....	1913	C.	49	1 yr., 6 mos.	5 mos.	2 yrs., 3 mos.	Died	Scirrhus	2 mos.	Chest, supra-clavicular.
8	Farr.....	1913	K.	49	.....	.....	.....	A. W.	Ca.	.....	.....
9	Gibson.....	1913	L.	41	.....	.....	.....	Died	Med. Ca.	14 mos.	Sternum.
10	Lee.....	1914	K.	45	1 yr., 6 mos.	5 yrs., 9 mos.	7 yrs., 3 mos.	Died	Scirrhus	.....	Without recurrence.
11	Lee.....	1914	M.	53	5 mos.	1 yr., 8 mos.	2 yrs., 1 mo.	Died	Scirrhus	1 yr., 6 mos.	Chest wall.
12	Lee.....	1914	H.	48	5 yrs.	2 yrs., 2 mos.	7 yrs., 2 mos.	Died	Scirrhus	2 yrs.	Spine.
13	Gibson.....	1914	C.	57	.....	.....	.....	A. W.	Scirrhus	.....	.....
14	Gibson.....	1914	S.	50	6 mos.	1 yr., 6 mos.	2 yrs.	Died	Ca.	1 yr., 3 mos.	Upper axilla, supra. nodes.
15	Hitzrot.....	1914	N.	47	2 yrs.	5 yrs., 4 mos.	7 yrs., 5 mos.	Died	Ca.	4 yrs., 6 mos.	Rt. supra., chest.
16	Lee.....	1915	M.	46	1 yr.	1 yr., 1 mo.	2 yrs., 1 mo.	Died	Duct. ca.	3 mos.	Cervical nodes.
17	Gibson.....	1915	O.	46	5 yrs.	9 yrs.	14 yrs.	A. W.	Ca.	.....	.....
18	Lee.....	1915	G.	60	8 mos.	4 yrs., 5 mos.	5 yrs., 1 mo.	Died	Ca.	?	Supraclav. nodes.
19	Hitzrot.....	1915	S.	51	2 yrs.	11 mos.	2 yrs., 11 mos.	Died	Simplex	4 mos.	Scalp.
20	Farr.....	1915	A.	47	8 mos.	1 yr.	1 yr., 8 mos.	Died	Medull. ca.	10 mos.	Chest wall.

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21	Lee.....	1915	Y.	45	6 mos.	5 yrs., 6 mos.	6 yrs.	Died	Ca.	5 yrs.	Supraclav. lumbar spine.
22	Lee.....	1915	O.	43	1 yr.	5 yrs., 7 mos.	6 yrs., 7 mos.	Died	Ca.	5 yrs.	Spine.
23	Lee.....	1915	F.	46	8 mos.	5 yrs., 10 mos.	6 yrs., 6 mos.	Died	Large abs.	2 yrs.	Spine.
24	Turune.....	1915	C.	38	7 mos.	18 mos.	2 yrs., 3 mos.	Recur.	Ca.	6 mos.	Chest wall incomplete.
25	Bancroft.....	1915	S.	28	9 mos.	1 yr.	1 yr., 9 mos.	Died	Scirrhus	7 mos.	Supraclav.
26	Bancroft.....	1915	S.	41	9 yrs.	7 yrs., 6 mos.	16 yrs., 1 mo.	Died	Scirrhus	22 mos.	Supraclav.
27	Pool.....	1915	P.	51	4 yrs.	6 mos.	4 yrs., 6 mos.	Died	Ca.	4 mos.	Supraclav.
28	Lee.....	1916	E.	39	6 mos.	7 yrs., 5 mos.	7 yrs., 11 mos.	A. W.	Adeno-ca.	.....	.....
29	Lee.....	1916	C.	40	1 yr.	2 yrs., 9 mos.	3 yrs., 9 mos.	Died	Scirrhus	9 mos.	Same breast.
30	Pool.....	1916	S.	53	4 yrs.	1 yr., 6 mos.	5 yrs., 6 mos.	Died	Ca.	few mos.	Supra. nodes later gen. metastases.
31	Hitzrot.....	1916	G.	40	11 mos.	6 yrs.	6 yrs., 11 mos.	Died	Ca.	3 yrs.	Skin, chest.
32	Bancroft.....	1916	B.	41	1 yr., 6 mos.	1 mo.	? ?	Recurrent	Ca.	1 mo.	Supraclav. nodes.
33	Erdman.....	1916	Y.	60	4 mos.	6 mos.	10 mos.	Died	Fib. ad. ca.	3 mos.	Supraclav. nodes.
34	Bancroft.....	1916	G.	16	4 yrs.	8 yrs.	12 yrs.	A. W.	Fib. ad. ca.	.....	.....
35	Erdman.....	1916	P.	47	6 mos.	8 mos.	1 yr., 2 mos.	Died	Ca.	? ?	Axilla, general metas- tasis.
36	Pool.....	1916	P.	67	1 yr.	3 yrs., 6 mos.	4 yrs., 6 mos.	Died	Scirrhus	.....	Lung metastasis.
37	Gibson.....	1916	F.	63	1 wk.	5 yrs., 1 mo.	5 yrs., 1 mo.	Died	Ca.	3 yrs., 1 mo.	Opp. breast and axilla amputation.
38	Lee.....	1916	N.	49	2 mos.	7 yrs., 4 mos.	7 yrs., 6 mos.	Died	Ca.	6 mos.	
39	Lee.....	1916	M.	54	2 wks.	1 yr., 5 mos.	1 yr., 5 mos.	Died	Ca.	6 mos.	Scar. Later gen. metas- tasis.
40	Gibson.....	1916	J.	60	2 yrs.	? ?	? ?	Recur.	Scirrhus ca.	5 yrs., 7 mos.	Axilla (could not com- plete).
41	Gibson.....	1916	F.	55	2 wks.	2 yrs. 1 mo.	2 yrs., 1 mo.	Died	Scirrhus ca.	2 yrs.	Spine.
42	Gibson.....	1916	D.	78	6 mos.	4 yrs., 3 mos.	4 yrs., 9 mos.	Died	Scirrhus ca.	4 yrs.	Gen. ca.

*A. W., Alive and well.

TABLE I.—Continued.

No.	Surgeon	Year	Name	Age	Before Operation	Duration After Operation	Total duration	Result	Pathology	Date metastasis	Metastasis
43	Farr.....	1916	R.	36	9 mos.	1 yr., 2 mos.	2 yrs., 4 mos.	Died	Ca.	1 yr., 5 mos.	Same breast neck.
44	Hitzrot....	1916	S.	53	10 days.	2 yrs., 6 mos.	2 yrs., 6 mos.	Died	Ca.	1 yr., 11 mos.	Chest, abdomen.
45	Farr.....	1916	S.	35	10 days.	7 yrs.	7 yrs.	A. W.	Scirrhus ca.	.....	Bones.
46	Hitzrot....	1916	M.	39	1 yr.	1 yr., 2 mos.	2 yrs., 2 mos.	Died	Scirrhus ca.	7 mos.	.....
47	Farr.....	1917	W.	28	2 mos.	1 yr., 1 mo.	?	Recur.	Ca.	1 yr., 1 mo.	Line incision, L. axilla.
48	Gibson.....	1917	B.	60	6 mos.	2 yrs., 5 mos.	2 yrs., 6 mos.	Died	Ca.	.....	.....
49	Bancroft....	1917	S.	40	4 mos.	3 yrs., 7 mos.	3 yrs., 11 mos.	Rccur.	Gclatinous ca.	3 yrs., 7 mos.	5-6 costal cartilages.
50	Gibson.....	1917	H.	52	1 wk.	4 yrs., 9 mos.	4 yrs., 9 mos.	Died	Ca.	4 yrs.	Brain, tibia.
51	Lee.....	1917	R.	35	1 yr.	10 mos.	1 yr., 10 mos.	Died	Ca.	6 mos.	Axilla, breast and ax- illa.
52	Farr.....	1917	M.	40	10 mos.	11 mos.	1 yr., 9 mos.	Died	Ca.	8 mos.	Local.
53	Hitzrot....	1917	B.	56	2 mos.	1 yr.	1 yr., 2 mos.	Recur.	Scirrhus ca.	9 mos.	Uterus, omentum.
54	Gibson.....	1917	M.	62	3 yrs.	4 mos.	3 yrs., 4 mos.	Died	Scirrhus ca.	?	?
55	Lee.....	1917	M.	63	2 wks.	3 yrs., 4 mos.	3 yrs., 4 mos.	Died	Scirrhus ca.	3 yrs., 4 mos.	Abdomen.
56	Lec. . .	1917	K.	70	9 mos.	1 yr., 4 mos.	2 yrs., 1 mo.	Died	Scirrhus ca.	8 mos.	Supraclavicular.
57	Farr.....	1917	L.	37	5 mos.	4 mos.	10 mos.	Died	Scirrhus ca.	2 mos.	Abdomen.
58	Gibson.....	1917	C.	43	?	4 mos., 3 mos.	?	Died	Ca.	?	Spine, axilla.
59	Bancroft....	1917	D.	30	3½ mos.	3 yrs.	3 yrs., 3½ mos.	Died	Fibro-ca.	2 yrs., 8 mos.	Spine.
60	Victor.....	1917	L.	45	5 wks.	2 yrs.	2 yrs., 1 mo.	Recur.	Ca.	1 yr.	Sternum.
61	Farr.....	1918	B.	43	1 yr., 6 mos.	3 yrs., 2 mos.	4 yrs., 8 mos.	Died	Scirrhus ca.	3 yrs.	Brain, lung.

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62	Gibson.....	1918	O.	54	3 mos.	2 yrs., 9 mos.	3 yrs.	Died	Fibro-ca.	2 yrs., 10 mos.	Same axilla.
63	Gibson.....	1918	H.	59	7 mos.	1 yr., 3 mos.	1 yr. 10 mos.	Died	Adeno-ca.	8 mos.	Intra-abdominal.
64	Gibson.....	1918	H.	53	1 yr., 6 mos.	4 yrs., 8 mos.	6 yrs., 2 mos.	Recur.	Sm. abscess	4 yrs.	Supracl. and ax. nodes.
65	Farr.....	1918	S.	36	1 mo.	6 mos.	7 mos.	Died	Adeno-ca.	2 mos.	R. breast, lung, liver spine.
66	Gibson.....	1918	M.	58	?	2 yrs. 6 mos.	?	Recur.	Fibro-ca.	2 yrs. 6 mos	Skin.
67	Hitzrot.....	1918	C.	45	1 yr.	3 yrs., 6 mos.	4 yrs., 6 mos.	Died	Fibro-ca.	2 yrs., 5 mos.	Skin, lungs, ribs.
68	Hitzrot.....	1918	N.	54	1 1/4 yrs.	4 yrs., 4 mos.	5 yrs., 10 mos.	Died	Scirrhous ca.	4 yrs.	Chest.
69	Bancroft.....	1918	B.	60	3 wks.	5 yrs., 6 mos.	5 yrs., 7 mos.	A. W.	Scirrhous	.....	.....
70	Erdman.....	1918	C.	43	7 mos.	5 yrs., 10 mos.	6 yrs., 5 mos.	Recur.	Fibro-ca.	3 yrs., 6 mos.	Right axilla.
71	Vietor.....	1918	H.	44	1 yr.	8 mos.	1 yr. 8 mos.	Died	Large abscess	5 mos.	Liver.
72	Hawkes.....	1918	T.	41	1 yr.	8 mos.	1 yr., 8 mos.	Died	Small abscess	few mos.	Gen. metastasis.
73	Vietor.....	1918	S.	40	3-4 mos.	5 yrs.	5 yrs., 4 mos.	A. W.	Ca.	.....	.....
74	Hawkes.....	1919	F.	60	3 mos.	5 yrs., 1 mo.	5 yrs., 4 mos.	A. W.	Adeno-ca.	.....	.....
75	Gibson.....	1919	A.	68	2 mos.	2 yrs., 7 mos.	2 yrs., 9 mos.	Died	Med. ca.	2 yrs., 10 mos.	Site operation.

TABLE II
Died Before 5 Years Post Operation Without Recurrence.

No.	Surgeon	Year	Name	Age	Before Operation	Duration After Operation	Total duration	Result	Pathology	Date metastasis	Metastasis
76	Bancroft.....	1917	B.	38	8 days.	1 mo., 4 days.	2 mos.	Died	Ca.	1 mo.	Same side.
77	Bancroft.....	1918	L.	56	5 wks.	11 days.	6 wks.	Died	Ca.	11th post-op.	day. Lobar pneumonia.
78	Erdman.....	1918	T.	46	2 mos.	1 yr., 6 mos.	1 yr., 8 mos.	Died	Fibro-ca.	Insane.	Died Ward's Is.—No recurrence.
79	Erdman.....	1918	U.	51	6 wks.	2 1/2 wks.	8 wks.	Died	Concdo-ca.	Pneumonia,	6 days after leaving hosp.
80	Gibson.....	1919	W.	33	?	?	?	Died	Ca.	Insane,	shortly after discharge. No recurrence.

TABLE III
Inconclusive—Not Followed—Not Recurrent When last Seen.

No.	Surgeon	Year	Name	Age	Before Operation	Duration After Operation	Total duration	Result	Pathology	Lost track of.
81	Gibson.....	1913	D.	44	1 mo.	1 yr., 7 mos.	?	?	Ca.	Lost track of.
82	Lee.....	1914	M.	45	1 yr.	2 yrs., 9 mos.	?	?	Ca.	Lost track of.
83	Lee.....	1914	M.	38	1 yr.	.....	?	?	Adcno-ca.	Lost track of.
84	Lee.....	1915	Z.	66	8 mos.	2 yrs., 4 mos.	?	?	Ca.	Lost track of.
85	Lee.....	1916	F.	40	1 yr.	1 yr.	?	?	Pap. cyst	Lost track of.
86	Hitzrot.....	1917	C.	50	1 yr., 6 mos.	1 yr., 3 mos.	?	?	Ca.	Lost track of.
87	Gibson.....	1918	M.	42	.....	2 yrs., 2 mos.	..	..	Fibro-ca.	Lost track of.

A description of the portion of the breast involved is given in 69 instances. The following table indicates the location of the tumor: Upper outer quadrant, 33; lower outer quadrant, 12; outer half, 8; mesial above nipple, 8; upper inner quadrant, 4; lower inner quadrant, 3; upper half, 1. Total, 69.

Correct Pre-operative Diagnosis of Carcinoma of the Breast.—A record of the pre-operative diagnosis was recorded in all instances. Percentage of correct diagnosis is as follows: Number of cases correct 81, 93 per cent.; number of cases incorrect - - -

6, 7 per cent. All surgeons appreciate the difficulty in making a correct diagnosis in every instance. The percentage given above is practically identical with that reported by Mills and Greenough and Simmons, the former giving 93 per cent. and the latter 94 per cent.

Pre-operative Diagnosis of Involved Axillary Nodes.—In four instances no statement was made as to the pre-operative impression of metastasis to the axilla. In 83 patients definite statements are recorded, giving the pre-operative diagnosis of the surgeon as to the involvement of



FIG. 3.—Radiograph of early chest metastasis.

axillary nodes. Believed to be positive 59; correct 49, 83 per cent. Believed to be negative 24; correct 19, 79 per cent. Total, 83.

This tabulation illustrates the difficulty of correctly diagnosing involvement of axillary nodes. The experience is universal to occasionally encounter considerable axillary metastasis where none was anticipated, and vice versa, to find hyperplastic lymph-nodes free from cancerous disease where definite malignancy was expected. Although deductions from a small group of cases are always dangerous, the table shows a lessened liability of error where the surgeon believes the nodes to be definitely involved.

Factors Influencing Prognosis.—Various factors must be considered in reaching a correct prognosis in any case of cancer of the breast. Each patient represents a complex problem due to the variable conditions afforded by age, the rapidity of growth, associated pregnancy, the pathological type of

tumor, the presence or absence of involved axillary nodes, the proper interpretation of the signs of early chest metastasis and of early metastasis to bone. We will briefly consider each of these factors.

Age.—Of the 75 cases completely followed, we have divided them into three age groups, namely:

TABLE IV

	Number	Number alive	Per cent. alive
I. Up to and including 50 years of age	19	4	21%
II. 41 to and including 60 years of age	49	7	14%
III. 61 years and over	7	0	0%

—
75

1. *Patients up to and Including Forty Years of Age.*—All authorities agree that other things being equal the younger the patient the more serious the outlook. In the present series the percentage in this age group alive and without disease five years or more after operation (21 per cent.) is distinctly higher than the average for the entire group. The reason for this high percentage in the younger women can be explained, partially at least, by the fact that all of the four living cases in this group were distinctly localized tumors without metastasis to the axilla. Further, Case No. 34 presented some very unusual pathological features, which will be discussed under the section on pathology, making it perhaps questionable whether this case should be included at all in the present study. If this case were excluded, the percentage alive would be 16 per cent. rather than 21 per cent. The small number of cases available for study in this age group makes any percentage figure inconclusive.

2. *Patients from Forty-one to and Including Sixty Years of Age.*—We feel that no special comment upon this group is necessary other than to call attention to the fact that it represents the approximate cross-section of percentage results five years after surgical treatment of the disease.

3. *Patients Sixty-one Years of Age and Over.*—Experience has generally proven that patients in this group, as a rule, do well following surgical intervention. Usually the rate of growth is slow, and the patients are apt to live many years following operation before menacing metastases occur. The group of seven cases is much too small from which to draw any conclusive deductions, but it perhaps illustrates that this group may not be as favorable as we have generally believed it to be.

Rapidity of Growth.—In general, a convincing statement by the patient that the growth of the tumor has been exceedingly rapid, should lead the surgeon away from rather than toward surgical intervention. We have frequently heard surgeons express the opinion that immediate radical operation should be undertaken, because the growth has been at such a startling rate. Such an attitude we believe to be an incorrect one, as the prognosis of these rapid cases, treated by radical surgery, is always bad, and we believe many of them would survive the disease longer if some other form of therapy were followed. If the growth is rapid and the woman is below forty, in general

we feel that operation is unwise. Practically without exception the rapidly growing tumors in the present series have succumbed to the disease within a few months up to two years of the date of operation.

Associated Pregnancy.—We are all thoroughly familiar with the extreme gravity of the prognosis in a case of carcinoma of the breast associated with pregnancy. These patients are usually young women, which adds further to the seriousness of the prognosis. In our series one patient (Case No. 2), twenty-six years of age, was seven months pregnant at the time of her admission to the hospital. Radical operation was advised and done by one of the writers with a rapidly disastrous result, the patient surviving the surgical intervention by but eleven months. The result in this case represents a judgment against the over-enthusiasm of youth. To-day no such management of the situation would for a moment be entertained. The almost immediate recurrence with the rapid extension of the disease was frightful. This patient finally died in the hospital with a huge massive involvement of the whole chest wall, extensive adjacent metastasis to the lung and pleura and ended with an opening several inches across, entering the chest cavity.

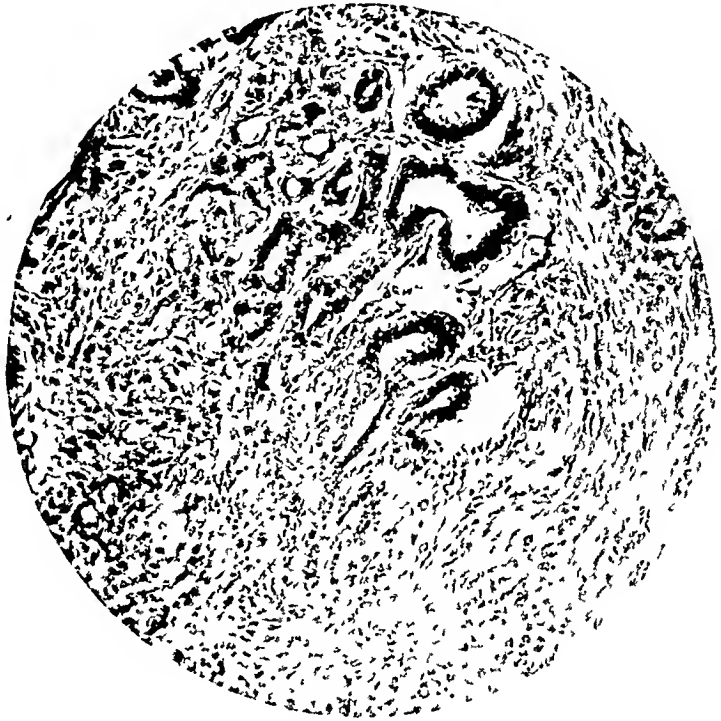


FIG. 4.—Low power photomicrograph of Case No. 34, fibro-adenocarcinoma, questionable malignancy.

The presence of a lactating breast associated with carcinoma is far less menacing to the patient than pregnancy. Three patients in this report were nursing children at the time of the breast amputation. Case No. 24 developed a recurrence in six months and died eighteen months post-operative, with extensive chest metastasis. Cases Nos. 59 and 70 also recurred, the first two years and eight months, and the latter three years and six months after operation. Pathological report in each instance was a fibro-carcinoma, which probably accounts partially for the delay in recurrence. Further, Case No. 70 received considerable prophylactic X-ray treatment over a period of two and a half years, which probably helped to delay the date of recurrence and the rate of growth of the tumor process.

Pathological Types.—Sistrunk and MacCarty and many others have pointed out the wide variations in pathological types of mammary cancer as to

the degree of malignancy. We are convinced that the term "carcinoma of the breast" in reality covers a group of diseases presenting widely different clinical courses and frequently distinctive pathological pictures. We believe that as more accurate knowledge of these pathological groups is obtained, the results of the treatment of cancer of the breast can be much better standardized. At the present time we are convinced that many cases are placed in the carcinoma group which really do not belong there. It is often difficult to properly interpret a pathological picture even when the interpretation is made by pathologists of the front rank. Case No. 34, in this present series, illustrates the difficulty in question. This young woman, sixteen years of age, was operated upon for what was believed to be a fibro-adenoma. A local removal of the tumor was practiced and upon the basis of the pathological examination by Elser, corroborated by Ewing, a local mastectomy was performed. A diagnosis of fibro-adenocarcinoma was rendered, but in the experience of both of these pathologists the tumor is quite unique. Sections of the tumor show nodules composed of a cellular epithelial growth which in part is of glandular type. These nodules are sharply defined by an unbroken limiting membrane. The surrounding fibrous tissue shows considerable overgrowth, with some disorder in arrangement. More recently in reviewing this slide, both Elser and Ewing expressed grave doubt whether or not one should include such a case in a group of cases of mammary carcinoma. If a more systematic effort were made to gather together unusual cases of this and other types, we feel that it might ultimately be possible to separate out cases of this sort from the cancer group.

The following table is appended setting forth the number of cases of each pathological group encountered in this series. Although a pathological report was rendered in each instance, in 27 cases the diagnosis of "carcinoma" only was made. The percentages of each pathological type in the 48 remaining cases is given. The percentage alive for each group is also added in a separate column.

TABLE V
Pathological Types

	Number.	Per cent.	Number alive 5 years with- out recurrence.	Per cent. of group alive.
Scirrhus ca	26	54	5	19
Fibro ca	5	10	0	0
Adeno ca	4	8	2	5
Alveolar ca	4	8	0	0
Medullary ca	3	6	0	0
Fibro adeno ca	2	4	1	50
Duct ca	2	4	0	0
Ca, simplex	1	2	0	0
Gelatinous ca	1	2	0	0
	—	—	—	
	48	98*	8	

* The 2 per cent. missing is accounted for by our eliminating from consideration any fractional percentages to facilitate interpretation of the table.

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Presence or Absence of Involved Axillary Nodes.—Of the 75 conclusive cases, pathological examination of the axillary contents proved the axillary nodes to be free from disease in 30 patients. Ten of these cases, or exactly 33 per cent. are alive and well at the present writing. This percentage is very much lower than the usual figure given by most writers, as will be seen from the following table :

TABLE VI

Percentage of Good Results in Cases without Axillary Involvement

Surgeon	Per cent. alive without recurrence
Lockwood	83 (4 yrs. or more)
Sistrunk and MacCarty	65 (5 to 8 yrs.)
Mills	63 (6 yrs.)
Greenough and Simmons	56 (5 yrs.)

It is a startling fact that only one patient of the entire 75 cases survived the five-year period without metastasis, where axillary nodes were found involved by the pathologist. This patient, Case No. 10, died without evidence of recurrence, of an intercurrent disease five years and nine months after operation. The almost uniformly bad result in the entire group following radical amputation in the presence of involved axillary nodes is the most striking feature developed by our study of this series.

Proper Interpretation of Signs of Early Chest Metastasis.—We believe that few surgeons to-day appreciate the early physical and radiographic signs of chest metastasis. Craver has pointed out that physical signs of early chest metastasis consist in “a peculiar limitation of breath sounds, especially marked during inspiration, covering a limited area of the chest. This may or may not be accompanied by fine, crackling râles during inspiration, or by pleural friction rubs.” It is only in the latter stages of chest involvement that such subjective symptoms as shortness of breath and a dry hacking cough may be expected. The radiographic appearance of early chest metastasis may be characteristic a considerable time before the appearance of any subjective symptoms. We feel certain that chest plates are not infrequently passed as negative when true evidence of extension of the disease to the chest is revealed in the X-ray plate. Surgeons, as well as radiologists, often look for pronounced shadows, which are seldom seen early in the course of chest metastasis. In a joint communication with Herendeen, one of the writers has pointed out that the evidence of early metastasis consists “of hazy, line-like streaks along the bronchi, extending in a radiating manner from the hilum out into the parenchyma of the lung. It is usually bilateral and is generally more pronounced upon the side corresponding to the primary tumor. One may also see ill-defined mottling which in more marked cases gives almost the appearance of miliary tuberculosis. There may also be noted enlargement of the nodes at the hilum of the lungs.”

Symptoms of Metastases to Bones.—Pain is the first symptom of metastasis to bones and the patient may complain before the X-ray plate will reveal

definite evidence of disease. The surgeon should be alert in investigating thoroughly any complaint of pain by the patient, especially in the region of the ribs, spine, pelvic bones or femur. Vague rheumatic symptoms should arouse the suspicions of the surgeon and a careful physical examination may reveal metastasis to bones in a patient who might otherwise be considered operable. In the order of frequency, bones involved are: Spine, pelvis, ribs (usually multiple), femur, other bones. In the present series, metastasis to the spine was known to have occurred in eight patients.

General Paths of Metastasis.—As most of the patients succumbing to the disease died outside of the hospital, no satisfactory statement can be made, concerning the situation or extent of metastasis. A considerable experience with mammary carcinoma has demonstrated that the most frequent path of metastasis is into the axilla of the same side, extending upward and ultimately involving the corresponding supraclavicular nodes. Metastasis into the chest is common and sometimes occurs early. Metastasis to the spine is unfortunately common and makes its appearance in the natural course of the disease, independent of any surgical intervention. The vast majority of cases coming to autopsy show almost invariably intrathoracic metastasis and often involvement of the liver.

Site of First Recurrence.—In 60 patients a note is made of the position of the first recurrence following operation. The subjoined table gives the percentage figures for the recurrent areas.

TABLE VII

	Per cent.		Per cent.
Supraclavicular (same side)	21	Intra-abdominal metastasis	9
Chest	19	Bones other than the spine	8
Spine	11	Opposite breast	6
Axilla (same side)	10	Opposite axilla	3
Adjacent skin	10	Brain	2
		Distant skin	1
			100

These figures can only give an approximate idea of the first situation in which evidence of the disease may be expected following operation. The careful follow-up of the present day would reveal a very much higher percentage of metastasis to the chest.

Treatment.—As surgeons, we have been accustomed to focus rather more upon the type of operation performed than upon the disease we are called upon to treat. Warren, in 1904, called attention to the fact that the result of the surgical treatment of mammary cancer depended largely upon the degree of malignancy of the process. Since the time when the modern radical operation devised independently by Halsted and Willy Meyer came into vogue, surgical treatment of this disease has been carried out with a high degree of technical skill. We have realized what a serious prospect faced the patient unless a complete removal of all malignant neoplastic tissue could

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be accomplished. Still, in spite of the excellent surgery performed in the treatment of carcinoma of the breast, the problem of its complete control remains most difficult.

The astonishingly good results which are frequently obtained by some form of incomplete operation have impressed many operators. Greenough and Simmons obtained 26 per cent. of good five-year results, while in our own series 50 per cent. of the cases treated by local mastectomy have remained well without evidence of disease up to the present time. Mills reports nine out of fourteen cases, or 64 per cent., well and without disease six years post-operative. If we consider for a moment the reason for this splendid showing for the incomplete operation, it will be immediately apparent that the cases upon which this type of operation has been performed are usually those of a relatively low grade of malignancy, or cases in which the diagnosis of carcinoma before operation was questionable. Pathologists generally appreciate that papillary cyst-adenocarcinoma, although grouped with the malignant neoplasms of the breast, is a relatively benign disease, and local mastectomy or even a wide local removal of the tumor may give a satisfactory end result in such a case.

In future surgeons should and will use the radical operation as the routine procedure for the majority of cases, but in exceptional instances a somewhat less extensive type of surgery may yield equally good results.

In this series but ten of the patients have received post-operative X-radiation, and most of these cases were treated by a technic which to-day is considered only reasonably efficient. Nevertheless, the average duration of life of these patients was three years and four months after operation. None of the ten were favorable cases, as axillary nodes were involved in each instance. The average length of life of 61 patients who received no radiation was three years, and this group included all of the favorable cases without metastasis to the axillary nodes. These figures are suggestive but not conclusive.

In the cases under consideration there was one operative mortality, Case No. 77 dying on the eleventh post-operative day from lobar pneumonia. The following table gives the operative mortality statistics in the hands of various operators:

TABLE VIII
Operative Mortality

Surgeon	Mortality per cent.
Leech	7
Greenough and Simmons	3.6 1894-1904
Halsted	3.6
Warren	2
Buchanan	1.5
Lee and Cornell	1
Sistrunk and MacCarty	0.5
Crile	0
Lockwood	0
Greenough and Simmons	0 1911-1914

Late Results.—The following table illustrates the marked variation in the statistics of good end results furnished by different surgeons:

TABLE IX

Surgeon	Number of cases	Per cent. alive 5 years without recurrence
Haggard and Douglass	111	46
Sistrunk and MacCarty	218	39
Peck and White	69	39
Tixier	150	38 (6 yrs.)
Bunts	248	33
Greenough and Simmons	95	32
Lindenberg	183	28
Wiesman	106	23
Ochsner	98	22
Lee and Cornell	75	15

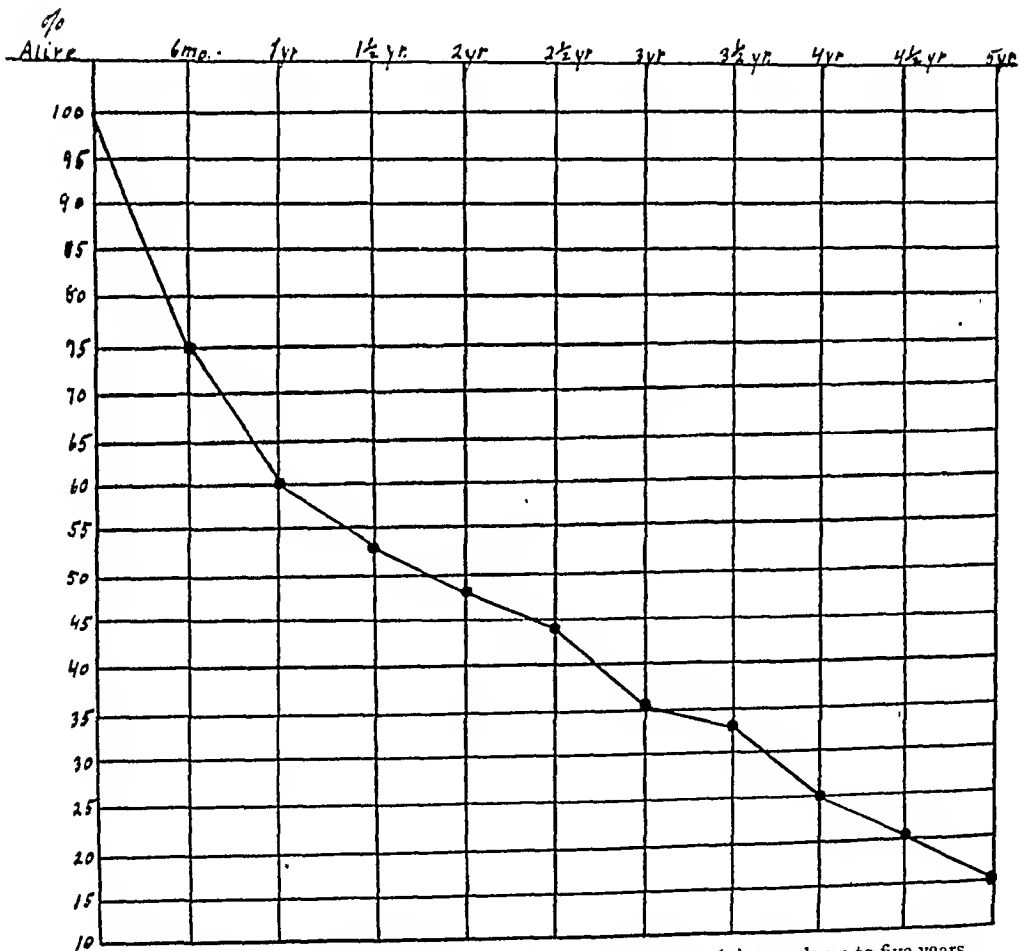


FIG. 5.—Table showing per cent. alive without recurrence at six month intervals up to five years.

The above graphic chart illustrates the rapid fall of percentages alive and well at six-month intervals down to the five-year period in the cases in this report.

CONCLUSIONS

1. Five-year results in the treatment of mammary cancer are the shortest ones worthy of report.
2. The five-year results in this series shows 15 per cent. alive and with no evidence of disease.
3. The term "cured" should be abolished and supplanted by "no evidence of disease to date."
4. Criteria of operability must be more sharply drawn.
5. The surgeon must learn to appreciate the physical and radiographic signs of early chest metastasis.
6. Metastasis to bones must be carefully excluded in every presumably primary operable case.
7. Continual follow-up of all post-operative cases is necessary if correct figures are to be obtained.
8. The term carcinoma of the breast probably includes a group of diseases differing in their pathology and their degree of malignancy.
9. Unusual pathological types should be collected in order that they may be separated out, the non-malignant from the truly cancerous.
10. In cases with involvement of axillary nodes, radical amputation usually yields disappointing end results.

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THE SURGICAL TREATMENT OF HEPATIC CIRRHOSES*

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MANN, in his classical experiments in the laboratories of the Mayo Foundation, removes the entire liver from dogs, and when they are about to expire a few hours later, he introduces a solution of glucose into their veins, which resuscitates them immediately; the period of resuscitation may be extended for from twenty-four to thirty-six hours by continuing the injection of the glucose solution at intervals, but all urea formation stops. This discovery emphasizes the metabolic functions of the liver, such as the metabolism of carbohydrates producing sugar for the heat and energy of the body. In the metabolism of proteins also, the final steps in the development of the amino-acids take place in the liver, and in the liver, likewise, the fats are made fit for use in the body.

A function of the liver deserving of attention, is that of the destruction of protozoa and bacteria that are removed from the blood stream by the spleen and intestinal organs of the portal system. Adami demonstrated that the sterility of the upper intestinal tract is due not only to the action of the gastrointestinal secretions, but to some extent to phagocytes which pass out of the portal capillaries to the intestinal surface, pick up particles of fat, and bacilli, and carry them into the radicles of the portal vein. The pigments of these microorganisms form the dark spots so common in the substance of the liver. Various bacterial toxins, and chemical poisons such as arsenic and phosphorus, are to a great extent detoxicated in the liver.

The bile might be regarded as a by-product of the metabolic processes in the liver, since the bilirubin of the bile is derived from the deteriorated red blood-cells destroyed in the liver and elsewhere, and excreted as bile pigment, and the cholesterol content of the bile, a lipid stored in fat, is liberated in the liver. Bile functions in intestinal digestion, especially in relation to the metabolism of fats, and many of the elements of bile, including water, are reabsorbed in the intestinal tract.

An interesting fact in connection with the function of the liver is that the liver acts only on non-oxygenated blood. Rowntree and Chaney are now carrying on in the Clinic certain interesting experiments in which arterial blood or oxygen is transferred to the portal circulation, to determine the direct effects of oxygen on the function of the liver. The liver is peculiar in that all its cells are alike; consequently its diseases are of a simple pattern, as contrasted with those of organs with highly differentiated cells which introduce varied architectural possibilities. The star-shaped cell of Kupffer is not a true liver cell, but probably an endothelial cell of phagocytic type developed in the liver tissue spaces with specialized functions of a problematic nature. The

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liver has remarkable powers of regeneration. Mann has shown that if 70 per cent. of the liver of a dog is removed, it will be replaced within twelve weeks, not alone by hypertrophy, but by hyperplasia of the remaining liver cells.

When the liver is overwhelmed by an acute destructive poison, bacterial or chemical, its cells undergo acute fatty degeneration, regardless of the nature of the toxic substance which produces it, and in forty-eight hours the greater part may be converted into fat. When the toxic invasion is chronic, connective tissue is developed instead of fatty degeneration. The type of cirrhosis is determined by the route by which the toxic substances enter the liver; if by way of the portal circulation, portal cirrhosis results, if through the bile channels, biliary cirrhosis. In the use of the term cirrhosis I have been guided more by the clinical aspects of cirrhosis of the liver as a whole than by the etiologic factors or the minute pathologic histology.

In portal cirrhosis, the most common type of cirrhosis, failure to eliminate or detoxicate toxic substances carried to the liver by the portal system leads to diffuse deposits of connective tissue around the portal vessels, which interfere with the hepatic circulation. Ascites, hemorrhage from the mucous surfaces, especially from the stomach, and other evidences of portal circulatory obstruction, are the end results of the vascular interference. The blood-pressure in the portal vein is about 30 mm., in the general circulation about 130 mm., and the back pressure on the portal circulation in portal cirrhosis is undoubtedly increased by the arterial counter-pressure. The work of Segall, showing the effect of ligation of the various branches of the hepatic artery on the circulation of the liver, is most interesting in this connection. In Laennec's type of portal cirrhosis, the liver is small, contracted, and nodular, but it should be noted that the cirrhotic liver may be normal in size, or considerably enlarged, and occasionally may be smooth from deposits of fat in the liver spaces.

There has been a tendency among pathologists, because of the varying morphology of the liver in portal cirrhosis, to describe each picture as a different type of cirrhosis, just as one might describe each pattern of wall paper or carpet as a different paper or carpet. Fagge, of Guy's Hospital, London early reported instances in which post-mortem examination revealed very advanced portal cirrhosis in men who, apparently in perfect health, had died suddenly as a result of accidents. With characteristic sagacity, Fagge pointed out that through collateral vascular connections, especially those described by Sappey, the portal circulation had been reduced in these cases to a point at which the decompensated liver was able to care for the circulation without the development of serious obstruction, ascites, or hemorrhage. Talma was the first to suggest the artificial establishment of a collateral circulation. Drummond, the physician, and Morison, the noted surgeon, working jointly on the same theory, introduced the operation of omentopexy to increase the collateral circulation, and attempted to produce vascular adhesions between the surface of the liver and the abdominal wall.

SURGICAL TREATMENT OF HEPATIC CIRRHOSES

The surgical treatment of portal cirrhosis by the Talma-Morison operation has given some good results. Of forty-seven patients operated on in the Clinic, seven died in the hospital, twenty-one were alive when last heard from, one being alive and well more than nine years after operation, another eight years, one more than seven, and one more than five years. The operation we have usually performed is made through an epigastric incision as for gall-stone disease, just to the right of the median line, which permits examination of the liver, and a second lower incision through the skin and muscle down to the posterior aponeurosis and peritoneum. The rectus muscle is separated from its posterior attachments, and the omentum is drawn from above down into the extraperitoneal pocket thus formed. The extent of collateral circulation established in this way is extraordinary. In several instances I made an incision nearby for other purposes, some time after omentopexy, and encountered so much venous bleeding that I had to desist. The Talma-Morison operation *per se* carries only a slight risk, but ascites, hemorrhages, and often œdema of the lower extremities of the patients for whom it is indicated, make any operation extremely grave. The high mortality of the earlier Talma-Morison operations was undoubtedly largely due to the abdominal drainage through which peritoneal infections were subsequently carried. We have not used drainage, but have aspirated whenever necessary during the weeks succeeding operation, while collateral circulation is being established. The peritoneum in such patients is exceedingly vulnerable. Fagge demonstrated that 10 per cent. of the patients who came to post-mortem through cirrhosis of the liver, also had a terminal tuberculous peritonitis.

My interest in splenectomy for the relief of portal cirrhosis was excited many years ago by the remarkable benefit, such as the disappearance of ascites, hemorrhages, and other evidences of portal cirrhosis, which so often followed removal of the enlarged spleen in the Banti stage of splenic anæmia. It is a fascinating theory that in cases of splenic anæmia the spleen, which belongs to the reticulo-endothelial system, is enlarged primarily, and the liver contracted secondarily, suggesting that the toxic substances are carried to the liver from the spleen, a splenic type of portal cirrhosis. This theory would also argue that in the common type of portal cirrhosis of the liver, the liver is contracted primarily and the spleen enlarged secondarily. In other words, the toxic substances are not carried to the liver through the splenic portion of the portal vein, but through the gastro-intestinal portion of the portal vein, a true gastro-intestinal type of portal cirrhosis, and this is borne out by the fact that the enlargement of the spleen which occurs with the gastro-intestinal type of portal cirrhosis is not nearly so great as that with the splenic anæmia type, and secondary portal cirrhosis. This contrast is well shown in the gastro-intestinal type of portal cirrhosis of pepper and alcohol habitués, which is usually of the Laennec type, with only moderate enlargement of the spleen.

Experience in removal of the spleen in splenomegalias of the splenic anæmia type with secondary cirrhosis of the liver encouraged removal of the spleen in cases of the gastro-intestinal type of portal cirrhosis of the liver.

Forty-two of the ninety-seven patients splenectomized for splenic anæmia in the Clinic had more or less portal cirrhosis. Four patients died in the hospital; twenty-one are alive, two more than nine years, three more than seven years, four more than five years, and so forth. The results from splenectomy were extremely good and, contrasted with those from splenectomy in the gastro-intestinal type of cirrhosis of the liver, were remarkable, which again argues for an entirely different interrelationship between the spleen and the liver in these two conditions.

In ten cases of splenectomy, with three deaths in the hospital, for advanced gastro-intestinal portal cirrhosis the results on the whole were disappointing; while the spleen was only moderately enlarged, it showed generalized thrombophlebitis and atrophy of the pulp cells comparable with that found in the spleens in cases of splenic anæmia, and, considering the difference in the anatomic structure of the spleen, with the cirrhotic process found in the liver. In nine other cases splenectomy was combined with a Talma-Morison operation. Two of the patients died in the hospital. These patients were bad surgical risks and were operated on in the terminal stages; the results are none too encouraging as contrasted with the brilliant results following splenectomy for splenic anæmia with secondary portal cirrhosis. The normal spleen furnishes about 20 per cent. of the portal blood, the enlarged spleen much more. Splenectomy must necessarily reduce hepatic circulation. Perhaps part of the improvement may be due to the increased opportunity for collateral circulation in the vascular adhesions which form in the bed from which the spleen has been removed. I had occasion to operate for gall-stone disease on a physician on whom twelve years previously, C. H. Mayo had performed splenectomy for advanced splenic anæmia with marked cirrhosis of the liver. It was with the utmost difficulty that I worked my way down to the encapsulated liver, which fairly floated in a venous plexus. The patient otherwise was in splendid condition. Removal of the spleen for these terminal conditions of primary cirrhosis of the liver entails considerable risk and should not be lightly undertaken, but in selected cases combined splenectomy and omentopexy should be considered.

What has been called "hepatic shock" is sometimes noted after comparatively slight operations on patients with very advanced decompensation of the liver, and in cases of portal cirrhosis the diagnosis will often be delayed, or the operation will not be considered until the function of the liver is reduced to the point at which recovery is doubtful. There have been several unfortunate experiences of this kind in the Clinic.

Rowntree, on the medical service, Walters on the surgical service, and Greene, on the laboratory service of the Clinic, in collaboration have developed interesting and valuable facts from tests of liver function which demonstrate that, when the function of the liver is reduced to below 25 per cent. any serious operation will probably end fatally. Mann has shown that if the function of the liver in the dog is reduced to a point below 20 per cent., the animal will probably die.

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In cases of biliary cirrhosis the liver is enlarged, dark colored, often soft, and has a tendency to bleed easily on slight injury. Biliary cirrhosis is most often the secondary result of infections and obstructive processes originating in the gall-bladder or the common duct, usually from gall-stone disease. As Adami has pointed out, stone in the common duct, or obstruction in the head of the pancreas, is the usual cause of dilatation of the fine biliary ducts. The slowing of the circulation of the bile invites infections in and around the small biliary channels, and the resultant introduction of connective tissue around the minute bile ducts produces obstructions in the liver which lead to early and continuous jaundice. The spleen is not greatly enlarged in this type of biliary cirrhosis. The biliary tract should be cleared of obstructions such as gall-stones, and free drainage of bile established; the results are usually good. Splenectomy is unnecessary.

There is another type of biliary cirrhosis in which there is no demonstrable infection or obstruction in the biliary ducts. The liver is enlarged and congested, but firmer in consistency than in obstructive biliary cirrhosis. All the biliary ducts are greatly thickened, and chronic jaundice exists. The spleen is enlarged and to a much greater extent than occurs in the obstructive type. It is interesting to speculate why the spleen is greatly enlarged in certain cases of biliary cirrhosis and not in others, and whether or not the splenic involvement is of definite significance. Hanot's name has been associated with an obscure type of hypertrophic biliary cirrhosis. I do not know just why his vague description, which has only added to the fog which surrounds the subject, should have resulted in an eponym.

Cases of what might be called the splenic type of biliary cirrhosis sometimes are graded according to the size of the spleen, but so far as I am able to judge clinically, the conditions associated with size are variations of essentially the same process. There are usually no gall-stones nor infections in this group, but if they exist, they are apparently incidental. The disease is very chronic and does not often present the acute symptoms exhibited in the obstructive type. Removal of the spleen sometimes seems to be indicated in these cases.

Just how removal of an enlarged spleen can be of benefit in such cases is a matter of speculation. The portal circulation in the liver is, of course, greatly reduced by splenectomy, and possibly this reduction is sufficient to reduce the amount of bile formed to the point where the obstructed channels can function. Splenectomy for hæmolytic icterus has been extraordinarily successful, yet we know little concerning the disease. Perhaps a closer relationship between hæmolytic icterus and certain splenic types of biliary cirrhosis may exist than is apparent on the surface. In twelve cases of splenectomy for the splenic type of biliary cirrhosis, there was one death in the hospital; five patients are alive. It is evident that such patients, at present, come to operation in a terminal condition, and are usually beyond the stage at which function of the liver can be restored.

There is a remarkable parallelism in the relation of an enlarged spleen to both portal and biliary cirrhosis. In the ordinary type of portal cirrhosis, it is often possible to trace the origin of the disease directly to the gastro-intestinal tract (for instance, to the irritation of alcohol and pepper), and the spleen is not greatly enlarged; the results of splenectomy are only fair. The operations usually performed have been at a terminal period, too late. In terminal portal cirrhosis seen in the Banti stage of splenic anæmia, the spleen is very large, and splenectomy may be curative. In biliary cirrhosis of the obstructive type of Adami, due to obstruction and infections such as are produced by gall-stone disease, the spleen is not greatly enlarged and there is no reason for splenectomy. Removal of the obstruction is sufficient. In these types of biliary cirrhosis in which there is no apparent infection or obstruction, in which the spleen is greatly enlarged, splenectomy may have value if not too long delayed. These facts lead to the tentative conclusion that there is a direct relation between the spleen and certain types of portal and biliary cirrhosis.

SUMMARY

In the present incomplete state of our knowledge, cirrhoses of the liver may be divided into two fairly definite groups: (1) portal cirrhosis, the result of deposits of connective tissue around the radicles of the portal vein, causing ascites and hemorrhages from the stomach, and (2) biliary cirrhosis, the result of deposits of connective tissue around the biliary duct system, causing chronic jaundice.

The portal cirrhoses may be of two distinct types clinically: a primary gastro-intestinal type, sometimes definitely the result of alcohol, pepper, or other irritating substances taken with food, in which the spleen is not greatly enlarged. In suitable cases, splenectomy and the Talma-Morison operation combined may have value. Splenectomy in addition to the Talma-Morison operation carries an increased risk, however, and before splenectomy is performed, the functional capacity of the liver should be tested. In the secondary splenic type of portal cirrhosis, occurring in the late stages of splenic anæmia, splenectomy gives splendid results.

The common forms of biliary cirrhosis are the results of obstructions and infections of the biliary ducts, usually associated with gall-stone disease, and removal of these infections and obstructions, in cases not too far advanced, can be expected to result in cure. The spleen is not greatly enlarged in such cases, and splenectomy appears unnecessary. There is a splenic type of biliary cirrhosis, however, very chronic in character, in which the splenomegalia is a prominent symptom and splenectomy may be indicated.

DIVERTICULITIS OF THE COLON*

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SECTION ON MEDICINE, MAYO CLINIC

DIVERTICULITIS of the colon deserves repeated consideration because of the frequency with which it is encountered and the severity of the symptoms manifested in some of the cases. The treatment for the condition has not been definitely standardized and it may be difficult to decide between operative procedures and less radical measures.

Diverticulitis was first described by Virchow, in 1853, although apparently very little was known about it for many years afterward. Graser, in 1898, described a formation in the lower colon which he believed to be an acquired type of diverticulum. Fischer, in 1899, also described the condition, but the first comprehensive article affording a study of the etiology and classification of the several types was that by Beer in 1904. In 1907, Mayo, Giffin, and Wilson reported the first series of cases (five) in which operation had been performed. The cases were studied from the standpoint of the clinical features, histologic changes in the tissues, and the results of surgical treatment. Moynihan's paper on mimicry of cancer of the colon appeared the same year. Since then, a number of detailed reports have appeared in the English literature, by Telling, Drummond, Mummery, Hartwell and Cecil, Brewer, Rogers, and others.⁵

Although post-mortem statistics would indicate that diverticulitis occurs rarely, clinical experience, especially in the last decade, would indicate that it occurs often. In the Clinic during the last year, one-third of the positive X-ray examinations made of the colon disclosed diverticulitis or diverticulosis. Diverticula may be found in any part of the gastro-intestinal tract from the œsophagus to the rectum, but the condition which we speak of as diverticulitis occurs almost altogether in the sigmoid. Protrusions are fairly common in the right, transverse, and descending colon, although they do not usually cause symptoms, probably because inflammation seldom occurs in diverticula in these areas. All diverticula of the sigmoid do not result in inflammation, or manifest clinical signs; nevertheless, the sigmoid as a focus for diverticulitis is characteristic. In no other part of the colon do we find the bowel studded with rows of small saccules and the curious inflammatory thickening of the mesentery and other structures. Diverticulosis, or symptomless diverticula, occur in any part of the colon. Diverticula of the sigmoid are more likely to become inflamed because the hardened fecal content of this part

* Read before the American Surgical Association, Baltimore, Maryland, April 17-19, 1924.

of the colon probably makes greater pressure within the sigmoid than in the other parts of the colon, and the fecal matter pressed into these saccules results in irritation and inflammation.

Etiology.—Diverticulitis is a disease of middle life and old age. The average age of patients is about fifty-five years. The condition has been reported as occurring at the age of eighteen years. Two of Mummery's patients were twenty-one and twenty-three years, respectively. The youngest patient in our series was a boy aged fifteen years, and the youngest on record is seven years (Ashhurst). The condition in this case was, we believe, verified by operation. The fact that diverticula rarely occur in young persons would indicate that they are not congenital, although this point has been widely discussed. Undoubtedly there is a congenital predisposition, possibly because of inherent weakness of the musculature. They are more common in the male, and in our experience are more common in fleshy persons. Constipation was one of the chief complaints in 63 per cent. of our cases. In our review of these cases, it did not appear that obstruction, either from stricture or adhesions, is a factor in the development of the diverticula. In most instances there was no demonstrable narrowing of the lumen of the colon below the site of the diverticulum, and furthermore, it is rather unusual to find diverticula in a colon which is markedly obstructed, so that while pressure must be considered a factor in the cause, some other factor must be responsible.

Hansemann and Klebs first called attention to the fact that the protrusions were closely related to the blood-vessels, entering and leaving the intestine along the mesenteric border. However, not all protrusions bear this relationship to vessels, and this explanation cannot, therefore, be applied to all cases. The part played by pressure and constipation, the blood-vessels, and the congenital weakness of the wall of the colon in the production of those diverticula has been widely discussed, but most observers agree that a change takes place in the resistance powers of the wall. This change is probably slow, and does not result in true diverticula until middle life. The inherent weakness, combined with the pressure of fæces and gases in the intestine, is undoubtedly responsible for the condition.

Early in their development, diverticula are probably microscopic in size, and all of the protrusions are true diverticula and contain all of the coats of the wall of the colon. Very early, the musculature disappears, although the mucous membrane remains undisturbed. In our experience they have not been large. They are more common on the lateral wall of the colon; occasionally they have a definite relationship to the fat tags. Our observations during the last few years lead us to believe that, in most instances, diverticula do not become inflamed, and hence do not produce symptoms. Since X-ray examinations of the colon have become reliable, we are finding many cases of diverticula of the colon without clinical manifestations. We agree with Spriggs that these cases should be called diverticulosis in contrast to the others in which inflammation has developed. Wilson called attention to the mode of development of the inflammation in cases of diverticulitis. In several of the

specimens he examined, there had apparently been an escape of bacterial irritants without the epithelium of the sac showing inflammatory changes. Just outside the submucosa and within the fat or subserosa, he found a diffuse infiltration with leukocytes and a marked increase of fibrous tissue. He called this condition peri-diverticulitis, and also directed attention to the fact that symptoms arising from the condition would be from inflammation in the peritoneum and not in the colon or diverticulum. It is likely that peri-diverticulitis is the condition represented by a rope-like sigmoid with extensive infiltration of the fat and mesentery.

Secondary Pathologic Changes.—Undoubtedly the diverticulum is the primary condition. It is not necessarily progressive, as shown by the fact that we have observed a great many patients for several years without discovering signs of change in the condition. The first change that occurs in the diverticulum is inflammation. We have recently been particularly interested in a study of the X-ray findings in these cases with regard to the marked tendency to spasm of the colon. Spasm of the colon is, of course, a common occurrence, but the frequency with which it occurs in cases of diverticulitis is significant. Inflammatory changes in a diverticulum are practically identical with the changes which may occur in the appendix. Diverticulitis has been called the left-sided appendicitis of old people. When the pouch becomes inflamed and fæces accumulate in it, the muscle atrophies, the mucous membrane becomes thin and ulcerated, the ulcer may perforate and result in a local abscess. This abscess may enlarge until it ruptures into the intestine, or seals itself to the abdominal wall and perforates to the outside, or it may burst into the bladder, resulting in a colovesical fistula. We have seen many patients in whom an abscess had formed and ruptured into one of these viscera, but as yet have not observed the development of general peritonitis. In the 118 cases of diverticulitis of the sigmoid in which operation was performed at the Clinic, fourteen localized abscesses were found in the peritoneal cavity, three in the abdominal wall, one in the wall of the bladder, one in the wall of the rectum, and one in the liver. Besides these, eight abscesses had perforated directly into the bladder, so that fæces and gas were passing through the urethra.

Usually the inflammatory process is chronic, and fibrous tissue is deposited in and around the colon. Many adhesions form, and often a tumor composed of dense fibrous tissue results. In this tumor small abscesses and diverticula containing fæces may often be found. The same condition usually occurs in several diverticula at once; the process is slow, probably taking several years. As a result of this chronic inflammation, stenosis of the sigmoid follows. The lumen of the sigmoid is reduced by the contraction of the fibrous tissue from the outside. The mucous membrane remains intact, so that in this respect a stricture from diverticulitis differs from a stricturing carcinoma. Blood was passed from the bowel in only 18 per cent. of the cases of benign diverticulitis, while it was found in the stool in more than 47 per cent. of the cases associated with carcinoma. A palpable tumor was present in 34 per cent. of the benign cases, and in 31 per cent. of those associated

with carcinoma. Constipation was one of the principal symptoms in about 60 per cent. of the cases, but enough interference with the bowel to cause obstruction was present in fifteen of the entire group of 137 cases. Many other patients had had obstructive attacks, as shown by the history, but there was no obstruction at the time they came for treatment.

It is likely that some of the patients with an indefinite history of chronic abdominal attacks have them as a result of inflammation in a solitary diverticulum. One of the problems which presents itself to the surgeon seems to be the decision of whether the symptoms are caused by the diverticulum. It has also been suggested that diverticulitis may act as a focus of infection, and be the cause of remote symptoms. Rogers, writing on diverticulitis, reports one case of this kind which was entirely relieved by treatment for the diverticulitis. The mesentery usually becomes oedematous and thickened, and extends up over the sides of the colon. As a result of this swelling, and often after the inflammation in the mesentery has subsided, the colon may be pulled into a distinct angulation, which may be the cause of obstructive attacks. As a result of this angulation, it is often difficult to examine the colon satisfactorily with the sigmoidoscope, but when the characteristic condition is found, it strongly indicates diverticulitis.

One of the interesting problems in the study of these cases is the association of carcinoma with diverticulitis. In the 118 cases in this series in which operation was performed, there was no evidence of carcinoma. During the same interval we operated on nineteen patients with diverticulitis of the sigmoid associated with carcinoma. Some years ago, Wilson called attention to the manner in which diverticula of the sigmoid might become carcinomas, comparing the cases of carcinoma of the stomach developing secondary to ulcer of the stomach, and carcinoma of the appendix developing secondary to inflammation in the appendix. We are unable to demonstrate whether this larger series of cases will bear out the contention that diverticulitis may result in cancer. In many of our patients in which carcinoma and diverticulitis were associated, there seemed to be no relationship between the two conditions, the carcinoma having apparently developed independent of the diverticulum. In some instances there were only one or two small diverticula remote from the carcinoma in the wall of the colon. It is probable that a patient with diverticulitis is no more likely to develop malignancy of the colon than one without it.

Clinical Manifestations.—One of the striking features brought out in our study of these cases was the number in which diverticulitis had been diagnosed, and in which there were no clinical manifestations. This is largely owing to the fact that the X-ray now shows much better detail of the colon than formerly, and probably the colon is being examined more routinely. We examined 615 cases of undoubted diverticula of the colon, but in only 137 were the symptoms sufficiently severe to warrant surgical intervention. We realize, however, that palliative measures can accomplish a great deal in some cases. The principal symptoms in our cases were pain, which was present

in nearly 80 per cent.; constipation, in about 60 per cent.; abdominal tenderness, in over 60 per cent.; gas in the bowels in over 30 per cent., and palpable tumor in 34 per cent. of the benign cases, and in 31 per cent. of those associated with carcinoma, thus showing that the presence of a tumor indicates diverticulitis rather than carcinoma, although this is not an important point in the differential diagnosis. When blood is present in the stool, it suggests carcinoma rather than diverticulitis. Frequency, and burning and pain on urination, often accompany diverticulitis of the sigmoid. Frequency was noted in more than 20 per cent. of our cases. Cystoscopic examination may be of value in cases in which the colon has perforated into the bladder. One of our patients, whose only symptom resulting from this condition was pus and mucus in the urine, had been treated a long time for cystitis, and the true condition was revealed only on cystoscopic examination. In the remaining seven cases in which there was a fistula between the colon and the bladder, the diagnosis could be made readily from the presence of inflammation in the region of the sigmoid, and the passage of gas and feces into the bladder.

Proctoscopic examinations are not of much value except to rule out other conditions. The lesion is likely to be too high to be reached with the proctoscope, and the deformity and angulation of the sigmoid make it inadvisable to attempt it. Fixation of the sigmoid may interfere with the passage of the sigmoidoscope in diverticulitis, and when found is corroborative evidence. We have seen the stoma of a single diverticulum through the sigmoidoscope, and also the rugous, fixed, mucous membrane lining a stricture due to diverticulitis.

In the differential diagnosis, if a mass is present in the sigmoid, the point of importance is to distinguish between the diverticulitis and carcinoma. This is often impossible, and in many instances in which the abdomen is open and the tumor palpated, it cannot be determined whether the lesion is diverticulitis or carcinoma, or diverticulitis and carcinoma. The history of repeated attacks of inflammation in the left lower abdomen with subsidence of symptoms is the rule with diverticulitis. But the case in which the patient presents himself within a short time after his first attack, with a palpable mass in the bowel, and partial obstruction still present, will always remain a diagnostic problem, so far as the differentiation of diverticulitis and carcinoma is concerned. The presence of blood or bloody mucus persistently in the stools indicates carcinoma. Ulceration of the mucosa in the strictured area of a diverticular involvement occurs occasionally, and severe bleeding may result, but this is rare. Persistent low-grade fever may be present with both conditions. Leukocytosis is a little more common with diverticulitis than with carcinoma, but there is not enough difference to be of value. We believe that, for the present at least, these two conditions must usually be distinguished by histologic examination of the tissues.

The X-ray reveals two types of diverticula: those associated with spasm, inflammatory thickening of the intestinal wall and partial obstruction, seen

most often in the sigmoid and called diverticulitis, and those distributed in various parts of the colon, without spasm, thickening or narrowing and called diverticulosis. When diverticula are filled with barium, they are seen as rounded or oval shadows projecting from the intestinal lumen. Such shadows, in conjunction with spasm or organic narrowing of the bowel, are pathognomonic of diverticulitis. The differential diagnosis is chiefly concerned with carcinoma, phleboliths, calcified glands, urinary calculi and barium pent up in contracted haustra.

Diverticula may fail to fill with barium if they contain fecal matter or have a stenotic inlet, and in such event diverticulitis may resemble carcinoma. Carcinomatous diverticulitis, if extraluminal shadows are present, cannot be distinguished from benign diverticulitis. By manipulation during the screen examination shadows of the concretions mentioned may be shown to have no relation to the bowel. Normal barium-filled haustra are not accompanied by a filling defect, and tend to disappear or to change their situation. Diverticular shadows maintain a fixed position and may persist after the bowel is emptied.

Treatment.—In view of the fact that we have seen a number of these patients, even when they had an abscess or a tumor, entirely relieved by conservative treatment, we are tempted to follow this plan in a large percentage of cases. We are, however, constantly confronted with the fact that the condition may be malignant, and that we are allowing an operable condition to become inoperable. We are convinced that the process is not progressive, and that unless there are symptoms from the diverticula no treatment other than palliative, such as regulation of the bowel movements, is indicated. Conservative measures, rather than operation, should be seriously considered in all of these cases. Operations have thus far been performed with a mortality of about 10 per cent. In operating, infection is the serious consideration. Although the tissues in these cases are not filled with bacteria to quite the extent that they are in cases of ulcerative colitis, nevertheless, there is usually a virulent infection in the wall of the colon and mesocolon. While the patient may be combating this satisfactorily before operation, the manipulation of the tissues may result in spreading the infection rapidly. We have operated on a number of patients who had abscesses, either just draining the abscess, or draining and suturing the opening left in the colon at the point of perforation of the diverticulum. In some instances the wound had healed readily, while in others fecal fistulas have persisted for a long time. If the condition is chronic, and results in obstruction from tumor and angulation of the colon, it is possible to resect the sigmoid and perform the anastomosis at one time, with satisfactory results in most instances. If, however, there is an appreciable amount of infection in or near the colon, or if there is a fistula from the colon leading into the bladder or other structures, the mortality will be reduced considerably by a preliminary colostomy, which accomplishes more than just the relief of obstruction. After the colostomy

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has been established, the distal part of the colon, which is affected with the diverticulitis, can be flushed out thoroughly once or twice a day until all evidence of infection has disappeared; the resection can then be performed with comparative safety. Because of the serious consequences following resection for diverticulitis, Mummery has advised permanent colostomy in some cases, being content with this procedure rather than operation at such risk. In most cases, however, we feel that after all the inflammation has subsided, resection and reestablishment of the continuity of the colon can be attempted.

TABLE I

BENIGN DIVERTICULITIS

January 1, 1907 to January 1, 1924

	Patients	Per cent.	Hospital mortality	Per cent.
Number	118		12	10.16
Males	84	71.18	8	9.52
Females	34	28.81	4	11.76
Oldest male	75 years		Oldest female	76 years
Youngest male	15 years		Youngest female ...	28 years

AGES BY DECADES

Years	Patients	Per cent.
11 to 20	1	0.84
21 to 30	1	0.84
31 to 40	12	10.16
41 to 50	37	31.35
51 to 60	42	35.59
61 to 70	18	15.25
71 to 80	7	5.93

TABLE II

BENIGN DIVERTICULITIS

January 1, 1907 to January 1, 1924

Symptoms:	Patients	Per cent.
Pain	90	76.27
Constipation	63	53.38
Abdominal tenderness	64	54.23
Gas in the bowels	42	35.59
Palpable tumor	41	34.74
Abdominal distention	27	22.88
Blood in stool	22	18.64
Painful bowel movement	20	16.92
Mucus in stool	15	12.71
Pus in stool	8	6.77
Liquid stool	3	2.54
Obstruction	11	9.32
Frequency of urination	24	20.33
Burning on urination	21	17.79
Pain on urination	17	14.40
Large amount of pus in the urine	11	9.32

JUDD AND POLLOCK

TABLE III

BENIGN DIVERTICULITIS

January 1, 1907 to January 1, 1924

Findings at Operation

	Patients	Per cent.
Location of tumor:		
Sigmoid	88	74.57
Rectosigmoid	7	5.93
Colon	5	4.23
Cæcum	5	4.23
Colon and sigmoid	4	3.38
Rectum	4	3.38
Not stated	5	4.23
Associated conditions:		
Adhesions	76	64.40
Perforation	31	26.27
Obstruction	25	21.18
Abscess localized in region of diverticula	14	11.86
Abscess in abdominal wall	3	2.54
Abscess in vesical wall	1	0.84
Abscess in rectal wall	1	0.84
Abscess in liver	1	0.84
Abscess under liver	1	0.84
Fistula into bladder	8	6.77
Fistula into sigmoid	1	0.84
Fecal fistula	1	0.84
Sinus of abdomen	1	0.84
Stones in the diverticula	4	3.38
Peritonitis	3	2.54
Associated findings:		
Gall-stones	5	4.23
Large spleen	1	0.84
Carcinoma of the pancreas	1	0.84
Inoperable carcinoma of the rectum	1	0.84
Duodenal ulcer	1	0.84
Tuberculous glands and secondary infection ..	1	0.84
Cyst of the liver	1	0.84

TABLE IV

BENIGN DIVERTICULITIS

January 1, 1907 to January 1, 1924

	Patients
Types of operation:	
Mikulicz	35
Tube resection	12
Resection	21
Colostomy	15
Excision of the diverticulum	15
Drainage of abscess	7
Anastomosis	7
Exploration	6
Total	118

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REPORT OF CASES

CASE I (A433746). *Extensive diverticulitis of the sigmoid relieved by cæcostomy.*—A woman, aged fifty-six years, had had an abdominal exploration one month before coming to the Clinic, because of pain in the left lower quadrant, lasting one week. A tumor 3.75 cm. in diameter was found in the sigmoid, causing adherence to the broad ligament. A cæcostomy was performed.

We found that the cæcostomy was functioning satisfactorily and the patient felt well, but she desired to know the nature of the lesion. Extensive diverticulitis of the sigmoid was demonstrated by X-ray. With control of diet, and irrigations, the patient continued to improve, and finally was sent home without further operation. She reports that she has been entirely comfortable thus far.

CASE II (A208146). *Diverticulitis of the sigmoid without marked symptoms.*—A woman, aged forty-six years, came to the Clinic because of intermittent and increased menstrual bleeding. She had had a goitre for twelve years, and slight constipation.

Our examination revealed multiple uterine fibromas, and an adenomatous goitre, which was not causing symptoms. At operation September 21, 1917, multiple fibromas, causing a tumor about 12 cm. in diameter, were found in the uterus. At the rectosigmoidal juncture was a mass 3 cm. in diameter which showed evidence of perforation, as it was sealed against the peritoneum covering the posterior portion of the uterus near the internal os on the left side. A subtotal hysterectomy was performed and the rectosigmoid juncture resected. The pathologists reported that the segment of sigmoid contained diverticulitis.

The patient recovered uneventfully from the operation and returned home. When told of the presence of the diverticulitis, the patient recalled that in the previous four years she had had occasional slight distress in the left abdomen accompanied by constipation and inability to pass gas; she had been relieved by a bowel movement or flatus.

CASE III (A387471). *Extensive diverticulitis of the sigmoid without marked symptoms.*—A man, aged fifty-six years, had developed a sore mouth, nine months before, and had noticed that he had a geographic tongue. Later his Wassermann reaction was reported to be positive, and he was given treatment for syphilis. In June, 1923, he passed a small amount of blood with his stool. In the three months which have intervened, his bowels have been regular until two weeks before coming to the Clinic, when he took Pluto Water. This was followed at first by a bloody discharge, and later by a severe hemorrhage, necessitating transfusion. Since the hemorrhage he had felt weak and sluggish, but had not had any pain or definite discomfort.

X-ray examination disclosed diverticula of the sigmoid with partial obstruction. At operation September 27, 1923, extensive diverticulitis and rather marked obstruction from long, thickened adhesive bands of inflammatory diverticula were found. The involved area was brought to the outside as the first stage of the Mikulicz operation, and ten days later was cut off. The patient's convalescence was somewhat retarded on account of the marked secondary anæmia, although two transfusions of 500 c.c. each had been given before the operation. The final stages of the operation were not completed, and after a month the patient was permitted to return home to complete his convalescence.

CASE IV (A387719). *Perforating diverticulitis of the sigmoid and vesicosigmoidal fistula.*—A physician, aged sixty years, one month before examination, had had a sudden, sharp, lower abdominal pain, followed by fever, a mass in the left lower quadrant, frequency and burning on urination, and the passage of gas by the urethra.

Examination revealed a great deal of pus in the stools, pus 2 and albumin 2 in the urine, hæmoglobin 68 per cent., and leukocytes 19,900. A median pelvic mass was palpable by rectum. Operation April 24, 1922, revealed that the sigmoid and descending colon were thick and œdematous; the descending colon was almost rope-like. The sigmoid was obstructed and densely adherent to the posterior wall of the bladder. All of the tissues were reddened, œdematous, and acutely inflamed; in some areas watery œdema was

present. The mesentery was thick and œdematous. A left rectus colostomy was performed. About a year later, inflammatory tissues around the colostomy wound, and an anal fistulous tract were excised. No evidence of malignancy was demonstrable in the tissues.

In the two years since the primary operation, the patient has regained his former weight, and he wrote recently that he was enjoying good health.

CASE V (A382782). *Diverticulitis of the sigmoid causing obstruction and marked toxæmia.*—A woman, aged fifty-five years, during the last four years had had three attacks of extreme soreness in the left iliac fossa, accompanied by a rise in temperature and severe constipation. An abdominal exploration revealed a mass in the sigmoid, but no attempt was made to remove it.

The nature of the tumor was of the greatest concern to the patient, although marked obstruction was evident at the time of our examination. The X-ray revealed multiple diverticula of the sigmoid and descending colon. The hæmoglobin was 67 per cent., the leukocytes 9900. At operation February 4, 1922, diverticulitis of the sigmoid had caused a suspicious-appearing tumor. The Mikulicz operation was performed in four stages. The pathologists reported multiple diverticula, averaging 1 by 0.5 cm. in diameter, and peridiverticulitis. Microscopically, there was no evidence of malignancy. About 30 cm. of bowel was removed.

The patient left our care in April, 1922, in good condition, and when last heard from, was improving steadily.

CASE VI (A93664). *Diverticulitis of the sigmoid with obstruction and spontaneous abdominal and vesicosigmoidal fistulas.*—A man, aged forty years, began to have abdominal cramps five years before coming to the Clinic. In an attack four years before, he had had chills, fever, and pain in the left lower quadrant followed by superficial inflammation. The inflamed area was incised and drained, but there was a rather persistent discharge of pus. One year later it was necessary to repeat the procedure, and several abscess pockets were evacuated. A third attack occurred one year before the visit to the Clinic, and was followed by a discharge of pus through the old sinus tract and also through the urethra. Two operations did not relieve this condition.

A fecal fistula was found in the left groin; it had been opening and closing intermittently for a year. The X-ray examination of the colon was unsatisfactory on account of the loss of bismuth through the fistula. Operation October 22, 1918, disclosed dense adhesions throughout the pelvis. A ruptured diverticulum of the sigmoid was discharging through the fistulous tract. The intestinal loop above the area of diverticulitis was dilated to three times normal. The involved sigmoid was resected and anastomosed by a tube.

The patient was dismissed from observation on the thirtieth day after operation in good condition, and has not been heard from since.

CASE VII (A453119). *Perforating diverticulitis of the sigmoid and vesicosigmoidal fistula.*—A man, aged fifty years, had had several attacks of constipation or diarrhœa, associated with abdominal cramps, fever, and occasional chills, for eight years. For the last ten days repeated cathartics had failed to obtain a bowel movement, although enemas resulted in the passage of a little gas and a small quantity of fecal matter.

Examination revealed marked tenderness over the descending colon, normal temperature, and 12,000 leukocytes. X-ray examination of the colon disclosed a filling defect in the sigmoid, and obstruction suggestive of diverticulitis. A day or two later, the patient suddenly developed frequency of urination, dysuria, and passed gas by urethra. There was increasing toxæmia and distention of the abdomen, especially the left lower quadrant. With a dietary régime and laxatives, the toxæmia decreased, and the bowels moved freely during the following two weeks. Operation February 11, 1924, disclosed acute perforating diverticulitis, communicating with the bladder. Colostomy was performed, and no further exploring done on account of the acuteness of the condition.

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Recovery was uneventful, and the patient left our care on the twenty-first day, feeling well.

CASE VIII (A442388). *Diverticulitis of the sigmoid. Relief of symptoms by medical management.*—A man, aged sixty years, had had mild lower abdominal distress, easily relieved by laxatives for one year. One month before, he had had an attack of severe lower abdominal pain followed by a rise in temperature, tenderness and rigidity in the lower left quadrant, and had been kept in bed for three weeks, because of swelling of the abdomen; this subsided.

Our examination disclosed nothing abnormal, grossly. X-ray examination of the sigmoid demonstrated the presence of diverticula. Mineral oil and a restricted diet were advised, and the patient left for home October 1, 1923.

In a report dated February 1, 1924, he states that he has gained 20 pounds, is not entirely free from symptoms, but has had only one day of severe discomfort and that occurred within the last month.

CASE IX (A376337). *Diverticulitis of the sigmoid and emphysema of the scrotum.*—A physician, aged forty-six years, in the last three years had had two attacks of intermittent left lower abdominal pain, lasting eight and six months respectively. The pain increased with defecation; it was accompanied by constipation, and at times a rise in temperature. There was frequency, and pain and burning on urination.

Urinalysis revealed pus 3 and albumin 1 in the urine. A rather marked cystitis was present. Rectal palpation revealed a mass in the region of the sigmoid, and the X-ray the presence of diverticulitis, causing obstruction. At operation, November 9, 1921, diverticulitis of the sigmoid was found. A loop of the small intestine (the ileum) had become attached to the mass and the posterior wall of the bladder, due to the inflammatory reaction, and the descending colon was dilated, giving evidence of obstruction. The infection was acute at the time, and there was considerable œdema and inflammation around the tumor. Primary resection seemed inadvisable because so many structures seemed to be involved, and a left rectus colostomy was made. November 6, 1923, after a long tedious dissection, the sigmoid was freed and resected, and an end-to-end anastomosis made.

On the seventh day after the colostomy, the patient rapidly developed an emphysema of the scrotum, but after puncture of the colostomy loop, the condition subsided. In the two-year interval between the operations, the patient gained 50 pounds. He is now waiting to have the colostomy closed.

CASE X (A448543). *Perforating adenocarcinoma and diverticulitis of the sigmoid; carcinoma of the ileum and obstruction.*—A man, aged fifty-eight years, had had three or four attacks of abdominal cramps eight years before, which were said to be due to appendicitis. Six months before, constipation had increased, and for three months was accompanied by abdominal cramps. Six weeks later he noticed a frequent desire to go to stool; the feces were liquid and contained much mucus. From this time on he lost strength and 25 pounds in weight. A few days before his visit to the Clinic he vomited for the first time.

Examination revealed tenderness over the lower abdomen, blood and excess mucus in the stools, and obstruction in the sigmoid. About forty-eight hours after examination of the colon, the patient developed tenderness and severe pain in the lower left abdomen, and became toxic. A definite mass was palpated at the level of the pelvic brim, but this disappeared after three weeks of hospitalization. Proctoscopy at this stage revealed a fixed lesion 20 cm. beyond the sphincter. On mineral oil and a soft diet he improved a great deal during the next three weeks. Operation, January 18, 1924, disclosed an adherent sigmoidal mass at the brim of the pelvis which gave the feel and appearance of a carcinoma. The sigmoid was indurated above the mass. There was no evidence of distant metastasis. A colostomy was performed, and a month later, the mass, which consisted of sigmoid, a loop of adherent ileum, and the appendix, were removed. There was an annular adenocarcinoma of the sigmoid 4 cm. long, and a carcinoma 2 by 1.5 cm.

long in the ileum. Glandular involvement was not demonstrable. Small diverticula were found in the bowel, both above and below the growth. March 25, the colostomy was closed and the continuity of the bowel reestablished. The patient's convalescence has been uneventful.

CASE XI (A147966). *Perforating diverticulitis of the sigmoid and mesenteric abscess.*—A man, aged fifty-two years, had had attacks of cramping pain in the left lower abdomen for one year. Enemas and mineral oil afforded moderate relief. The left lower abdomen had been tender since an attack of abdominal pain three weeks before. The bladder was irritable at this time.

Examination revealed tenderness and a mass in the left lower quadrant. X-ray examination of the sigmoid revealed diverticulitis. Operation, December 28, 1915, disclosed a tumor of the sigmoid 10 cm. long, closely adherent to the pelvic wall, extensive inflammatory reaction in the surrounding tissues, and an abscess in the mesentery with the tip of the appendix drawn into it. The appendix was removed and the first stage of the Mikulicz operation performed, bringing the tumor and 25 cm. of the bowel to the outside through an incision in the left rectus muscle. January 5, 1916, the second stage of the Mikulicz operation was performed, and the tumor removed. January 18, the third stage was performed. The patient recovered satisfactorily.

CASE XII (A399677). *Diverticulitis of the sigmoid and vesicosigmoidal fistula.*—A man, aged sixty years, had had attacks of pyrexia for five years, and had noticed large amounts of sediment in the urine, and for three years, flatus at the end of micturition.

Urinalysis revealed albumin 2 and pus 3. Cystoscopic examination revealed an opening in the wall of the bladder through which fecal matter could be seen. X-ray examination of the colon revealed diverticulitis. At operation August 29, 1922, it was found that the opening in the bladder had occurred at about the middle of the left lateral wall. Many diverticula were present in the sigmoid above the point of its attachment to the bladder. The sigmoid and bladder were separated and the openings closed.

The convalescence was uneventful, although prolonged on account of an indolent superficial fistula in the region of the left groin; this eventually healed spontaneously.

CONCLUSIONS

1. Diverticulitis of the colon is more common than was formerly believed. There may be a solitary diverticulum in any portion of the colon, or a great many diverticula distributed from the ileocaecal valve to the rectum.

2. Diverticulitis is apparently not progressive, and may remain unchanged for years. In many instances it apparently does not cause symptoms.

3. Diverticulitis is a disease of middle life. The condition we speak of as diverticulitis is peculiar to the sigmoid. We have not observed the condition, which is a diffuse oedema, inflammation, and swelling throughout all of the tissues of the colon and mesentery, in any other quadrant of the colon.

4. As the inflammation in the diverticula and wall of the colon progresses, an abscess may form and later perforate into the abdominal wall, bladder, or intestine. If the inflammation remains chronic, a tumor composed of fibrous tissue and the products of inflammation develops.

5. It is often difficult to distinguish between diverticulitis of the sigmoid and carcinoma; in a number of the cases the conditions are associated. Just what influence diverticulitis has on the development of carcinoma, we are unable to determine. If the history reveals that the patient has had repeated similar attacks, and has noticed a tumor for a long time, increasing and receding from time to time, the probability is that it is due to a diverticulitis. In

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some instances, a definite diagnosis cannot be made until the tissues have been examined histologically.

6. Many patients with diverticulitis can be relieved by dietary and medical management.

7. If an abscess forms from the perforation of a diverticulum, or extension of the infection through the wall of the colon, drainage is indicated. If perforation occurs into other regions, an operation is the only procedure that offers relief.

8. If there is any question as to the nature of the tumor, operation is indicated.

9. The mortality from radical operations for diverticulitis has been very high. The difficulty in these cases has arisen from stirring up the infection that existed in the tissues around the colon before the operation. It seems to us from a review of the results in these cases, that the plan of procedure should be a preliminary colostomy for the purpose of caring for any obstruction in the colon, and particularly the reduction of the inflammation in the diverticula by frequent irrigations of the lower colon. Resection of the infected portion can then be made with less risk.

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SURGERY OF THE RIGHT HALF OF THE COLON*

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THE right half of the colon differs embryologically from that of the left half. The proximal colon is developed from the mid-gut. It comprises that portion of the bowel which extends from the ileocæcal junction to the splenic flexure. This portion of the bowel, especially the cæcum, the ascending colon and the hepatic flexure is a frequent site of disease.

Within recent years much has been written on the subject of carcinoma of the large bowel. However, a careful perusal of the literature will show that the attention of surgeons has been focused chiefly on that portion of the colon which is most frequently affected, that is, the sigmoid, recto-sigmoid and rectum.

It is very difficult to obtain a careful comparison of the occurrence of cancer of the colon to that of other organs. In the collected statistics of Hoffmān, he gives as the cause of death in the registration area of the United States in the years from 1908 to 1912, cancer of the stomach and liver, 80,316; cancer of the buccal cavity, 7716; of the skin, 7585; of the female generative organs, 30,997; of the female breast, 18,884; of the peritoneum, intestines and rectum, 25,644; and cancer of other or unspecified organs, 31,559. It is interesting to note that when this is considered at the rate per 100,000 of population 7.7 of the male and 11.3 of the female deaths are due to cancer of the peritoneum, intestines and rectum. It is of further interest to note that while in 1900 only 5.7 of the deaths per 100,000 were due to cancer of the peritoneum, intestines and rectum; in 1913 this had risen to 10.5. It may be said that this increase was due to more careful diagnosis. On the other hand, Hoffman points out that "there is no evidence that the disease groups to which cancer might erroneously have been assigned have materially decreased, if at all, coincident with the gradual rise in the cancer death rate."

When we come to consider the frequency of cancer of the large bowel with that of the small bowel, we find the following statistics:

At the Pathological Institute of Vienna, of 343 intestinal carcinomas which came to autopsy, 164 were in the colon and 162 in the rectum, while only 7 were in the duodenum and 11 in the ileum. In Schleip's collection series of 542 intestinal carcinomas, 257 were in the rectum, 269 in the colon, 20 in the duodenum and 16 in the ileum. In Brill's series of 3563 intestinal tumors 97.5 per cent. were in the colon, appendix or rectum. In Herman's collection of 20,544 cancer cases, 1706 had a lesion in the large intestine, 1204 in the rectum and only 20 in the small bowel.

An analysis of numerous statistics made in order to determine the frequency of cancer of the various anatomic parts of the large bowel gave the

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following figures. In Mummery's collection of 188 cases of cancer of the large intestine, exclusive of the rectum, 103 had carcinoma of the sigmoid flexure, 6 of the descending colon, 12 of the splenic flexure, 17 of the transverse colon, 3 of the hepatic flexure, 6 of the ascending colon and 41 of the cæcum. At the Mayo Clinic from January 2, 1915, to December, 1922 of 359 cases of cancer of the colon; 71 were of the cæcum; 44 of the ascending colon; 28 of the hepatic flexure; 50 of the transverse colon; 23 of the splenic flexure; 39 of the descending colon; and 104 of the sigmoid flexure.

Of 511 deaths from carcinoma of the large bowel reported by Azeman, Maydl, Müller and Nothnagle, 35 were from cancer of the cæcum (6.8 per cent.); 131 the colon (25.6 per cent.); 83 the sigmoid (16.2 per cent.), and 262 the rectum (51.2 per cent.).

Erdman, in a series of 108 cases of carcinoma of the large bowel, reported 39 in the recto-sigmoid, 4 in the left one-quarter of the transverse colon and the splenic flexure, 12 in the hepatic flexure and the right three-quarters of the transverse colon; the remainder of the cases he did not localize.

It is in general agreed that if we consider the question of carcinoma of the colon, excluding those of the rectum, about 36 per cent. occur in the sigmoid, and 25 per cent. in the cæcum, the transverse colon and the splenic flexure; the hepatic flexure and the ascending and descending colon are accountable for the rest in about that order of frequency. In the Lankenau Clinic among the last sixty cases requiring surgery (exclusive of fecal fistula and non-malignant obstruction) the right half of the colon was involved fifteen times, or 25 per cent. of the cases.

Before taking up the various clinical aspects of the subject, it is of importance to discuss the factors which may predispose to the development of carcinoma in this portion of the bowel. This is especially true if we accept as true the statistics which show a steady increase in the incidence of the disease. If we can recognize the conditions which precede and those which produce cancer of the colon, we will have taken a long stride forward in its control and prevention.

Trauma to the bowel, as elsewhere, is a common predisposing factor in the production of cancer. Added to this we have the various degenerative changes which occur in the body tissues, which have been ascribed merely to age and again to intestinal putrefactive processes, and still again to syphilis. The most important factor, however, is unknown. It may be organismal or not. It may be, however, that this unknown factor acts in conjunction with one or the other of the known factors and the absence or presence of one or the other decides for or against malignant degeneration.

The right half of the bowel affords an excellent illustration of the manner in which trauma produces ulceration and carcinoma. I am one of those who believe that chronic ulceration plus traumatism is all that is necessary to produce malignant change. The lesions of the tongue are also an excellent example of this. The cæcum and hepatic flexure may be compared with the sites in the œsophagus and the cardiac and pyloric portions of the stomach

where cancer develops in those locations subject to constant injury. Most of us will agree that if the irritant is allowed to exert its baneful influence over a sufficient period malignancy results.

In the large intestine stasis is very frequent. Marked ptosis of the transverse colon with a resulting increase in the back pressure in the right half of the colon affords sufficient trauma. Associated with this we frequently find the mucous membrane showing varying grades of inflammation.

When we come to consider the difference in frequency in cancer of the right half and of the left half of the bowel, it should be pointed out that the consistency of the contents of the large intestine varies, for while in the cæcum and ascending colon it is still liquid or pasty, in the iliac and pelvic colon it is hard and firm. The greater frequency of cancer of the cæcum in comparison with that of the splenic flexure may be due to the fact that the caput of the colon is similar to a reservoir.

It is unfortunate, though true, that the surgeon is still not consulted until either the tumor is grossly palpable or the patient is suffering from an acute or chronic obstruction. Although outwardly these may be the first signs, a careful history will show that the patient has had either pain, cramp-like in character, or discomfort, giving only a sense of some intestinal derangement. At times the patient will localize accurately the area in which exaggerated peristalsis is attempting to overcome a partial obstruction. Long before the tumor is palpable, borborygmi may have been noticed. Irregularity in fecal evacuations are fairly constant and, if the lesion is in the right half of the colon, this may be in the form of diarrhoea. Sir Berkeley Moynihan has said that in his cases "it was very rare to find constipation as a symptom of a growth in the right colon, and rare to find it absent in a growth of the left colon." The constituents of the fæces may also be altered and blood is probably always present and can be found if repeated examinations are made. The excess of mucus associated with colonic tumors is due to an inflammation of the mucosa above the growth. An early anæmia is especially significant of tumors in the right half of the colon, Moynihan finding it in 50 per cent. of the patients with growths of the ascending colon and in 20 per cent. of all colonic growths. In fact, the blood picture may simulate that of pernicious anæmia.

The tumor at first is small and may not be palpable unless the individual is thin. At times the tumor felt is not the actual growth, but is an accumulation of fæces behind it. Occasionally visible peristalsis is present, or if this cannot be seen, under careful palpation the bowel may be felt to distend and then slowly to relax under the hand, as the contents of the colon pass the obstruction.

Carson, in his analysis of 111 colonic cancers, found that 68 (62 per cent.) were in the iliac or pelvic colon, of which 50 per cent. were obstructed; 18 (16 per cent.) were in the cæcum or ascending colon, of which 33 per cent. were obstructed; 9 (8 per cent.) were in the transverse colon, of which 6 (66 per cent.) were obstructed; 9 (8 per cent.) were in the descending colon, of

which 7 (77.7 per cent.) were obstructed; and 6 (5¼ per cent.) were in the splenic flexure, of which all were obstructed. This shows that the neoplasms of the right half of the colon are second in frequency to those of the ileopelvic colon and are much less liable than any of the growths of the large bowel to become acutely obstructed, while the splenic flexure and descending colon growths are obstructed in 90 per cent. of the cases.

The patients are usually in advanced life, but numerous cases have been reported between the ages of twenty and thirty, so that youth does not exclude the possibility of cancer of the colon. Statistics show that the male is more commonly affected than the female, the proportion being from two to one to three to one.

I feel that it is a mistake to rely too much on the X-ray examination in diagnosis. In fact, where the clinical diagnosis has been clear, the X-ray findings have frequently been negative. The surgeon who waits for the X-ray to give positive findings may miss the favorable time when radical operation may affect a cure.

The chief conditions to be differentiated from cancer of the right half of the colon are tuberculosis and actinomycosis, bands and adhesions causing partial obstruction, chronic appendicitis, and occasionally diverticula. Since these conditions are primarily surgical, it would seem that accurate diagnosis is only of academic interest, while procrastination is accompanied by serious hazards.

The colonic cancer usually develops slowly. It remains restricted to the intestinal wall for a long time. Sampson Handley, some years ago, shocked the surgical profession when he announced that he had found permeation of cancer cells six inches from an apparently localized growth. However, I think he later partly denied the assertion. There can be no doubt that for a long time adeno-carcinoma of the right colon is confined to the mucosa and submucosa. During the process of growth the cells spread by (a) direct extension, (b) through the venous system, (c) through the lymphatic system. Hausmann's statistics are of the greatest importance. Thus in 112 autopsies on cases of cancer of the colon, in 21 the disease had spread beyond the bowel and become generalized; in 36 only the primary lymphatic glands were enlarged; and in 55 the disease was limited to the bowel. These figures compiled from patients dying of cancer of the colon showed that fifty per cent. of them had died without any sign of the growth outside of the bowel. This low-grade malignancy of these cancers should afford the surgeon an opportunity for excellent results if the cases are operated before contiguous structures are involved.

In 359 cases from the Mayo Clinic, 140, or about 39 per cent., had metastasis to lymph-nodes or to other organs. In these the primary growth was in the cæcum in 34 cases; in the transverse colon in 25, and in the sigmoid in 36. Stated in percentages metastasis had occurred in 48 per cent. of the cæcal growths, 50 per cent. of those in the transverse colon, 35 per cent. of the sigmoid cancers, and 31 per cent. of those situated elsewhere.

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Only one who has operated on many of these cases can understand the varying malignancy of colonic tumors. In no other part of the body is there a wider variation in the degree of malignancy. The duration of life after simple colostomy in inoperable cases is often prolonged as compared with that of inoperable carcinoma in general. The virulence of bowel cancer depends more upon the seed than the soil. The colloid cancer is most malignant, the scirrhus cancer next, and the fungating type the least malignant. Generally the growth is slow, and for a long time the disease is limited to the bowel, the lymphatic glands being invaded late.

With such a state of affairs it is interesting to inquire into the number of patients presenting themselves for treatment who are suitable for a radical or a palliative operation. These statistics must be accepted with some reservation since surgeons vary in their opinions as to radical operability, and furthermore, the older statistics show a lower operability than the more recent ones. This is ideally illustrated in the Mayo Clinic reports where, during the years 1910 to 1913, 51 per cent. of the cases of cancer of the rectum had the radical operation, while in the succeeding two years (1913 to 1915) 71.8 per cent. of the cases were deemed suitable for radical intervention. Accurate statistics on the operability of tumors of the right half of the colon are not available, since what one surgeon considers suitable for radical intervention may be considered unsuitable by another. Again, I quote the statistics from the Mayo Clinic. In the 359 cases of cancer of the colon before mentioned, 125 were in the cæcum and ascending colon, and over two-thirds were found suitable for radical resection. McGlannan, in a series of 98 cases of cancer of the colon, found that 61 gave a history of an obstruction of some sort before operation. The suitability of the lesion for radical operation depends first upon the location of the area, second, upon the extent of the lesion and the metastasis, and third, upon the associated local or general disease. Under this heading I also consider obesity, since this is a disease, and there can be no doubt that the mortality is higher in obese patients.

There are definite contra-indications to the radical operation. If the lymphatic glands at a distance from the area to be excised are invaded by cancer cells, I doubt the advisability of the radical operation. The removal of the lymph-glands in the ileocæcal region is comparatively simple, since these glands lie along the ileocolic and the right colic arteries. Enlarged glands are not necessarily cancer invaded. Jameson and Dobson have carefully worked out the lymphatic drainage of the colon. They classify the glands into four groups: (1) the epicolic glands which lie on the bowel wall, and drain into the next two groups; (2) the paracolic glands, which lie in the mesentery along vascular arches close to the gut; (3) the intermediate glands, lying on the arterial branches between the vascular arcades and the main trunk, and the main glands situated around the colic arteries close to their origin, and into which all of the foregoing drain. It must be remembered that infection, which invariably accompanies cancer, may be the cause of glandular enlargement. On the other hand, growths in the hepatic flexure and the right half

of the transverse colon metastasize to glands about the pancreas and along the side of the aorta. The radical removal of the carcinoma in this latter region is, therefore, much more difficult and is attended by greater hazards. All of us have seen cases in which only local excision of the growth was practiced and the patient lived comfortably for a number of years. Paul, of England, emphasized this in 1912 when he said, "Many cases having the minute structure of cancer have not recurred, though known to have been removed within an insufficient margin of safety." He also said, "malignant disease of the bowel is very rarely removed during the early stage, yet the percentage of cures is remarkably good." Further contra-indications to the radical operation are deep invasion of the muscles of the posterior abdominal wall or extension to the parietal peritoneum. Moynihan believes that it is feasible to remove the invaded muscles without adding to the gravity of the operation, thus the contra-indications also vary according to the surgeon. William J. Mayo has shown that with increasing boldness and skill on the part of the surgeon in attacking growths of the large bowel the percentage of patients cured has been greatly increased, even though the operative mortality has been increased.

Whether the operation should be done by the one, two or several stage method is a matter of some controversy. The pioneers in this field resorted to the use of a temporary colostomy done either at the time of the radical operation or as the first stage of this operation. As surgery progressed, and as infection and wound healing were better understood, the one-stage operation took precedence over the two-stage procedure. I believe that in the ileo-cæcal region conditions still favor the one-stage operation. The contents of the bowel are fluid and their infective power is not nearly so great as in the left half of the colon. The ileum is nearly completely covered with peritoneum and the peritoneum of the large bowel is sufficient to give adequate serous approximation. Resection of the right half of the colon is therefore safer and easier than of the left half. To these factors may be added the greater mobility of the right half of the colon and the fact that its blood supply is more constant than that of the left half. Judd and Rankin have suggested ileostomy in all resections of the colon. This, they say, serves as a "safety valve." The only indication that I can see for the two-stage operation for cancer in the right half of the colon is in cases suffering from acute obstruction when first seen.

Cumston and Vandervere, in 1902, reported 83 cases of excision of the cæcum for cancer. Of 73 of these in which accurate statistics were obtained, 30 died under the operation and 43 recovered from the operation. McGlannan, in 1914, reported 32 cases of cancer of the cæcum, 10 of whom were cured, 18 of whom were dead, and 4 of whom were living but inoperable. He also reported 17 cases of cancer of the ascending colon and hepatic flexure, one of whom was cured, 15 of whom were dead, and one living and inoperable. How long after operation the death occurred, or how long after operation the "cures" were reported is not stated in his report.

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In McGlannan's cases a two-stage operation was done when acute obstruction was present, and a one-stage operation in the other cases.

Other conditions which are occasionally met with in the right half of the colon requiring operation are actinomycosis and tuberculosis. These practically always occur in the cæcum. Waring reported seven cases of actinomycosis of the cæcum or appendix and to these have been added 14 cases by Brogen, ten of which originated in the ileocæcal region. Two forms of the disease are seen, the acute form which resembles appendicitis, and the chronic form, which is insidious in onset and associated with slight, indefinite pain in the right lower abdomen. Occasionally there is no pain, a mass being the first sign of the disease. In both types there is marked loss of weight and strength, associated with a pronounced anæmia, the skin over the mass becomes bluish-red and sinuses are frequent. Constipation and not diarrhœa

TABLE I.

Summary of Operations on Right Half of the Colon: Fifteen Cases, Among Last Sixty Cases of Surgery of the Colon. (Exclusive of Fecal Fistula and Obstruction.)

Diagnosis	No.	Operation	Resection and ileocolostomy	Ileosigmoidostomy	Ileocolostomy	Ileojunostomy	Total
		Exploratory					
Carcinoma cæcum.....	5	I	I	I	2		5
Carcinoma hepatic flexure..	2			I	I		2
Carcinoma ascending colon.	4		3		I		4
Tbc. cæcum.....	4	I	2			I	4
	15	2	6	2	4	I	15

is the rule. The difference from carcinoma is that the latter is slower in growth, the anæmia is not so pronounced, diarrhœa is the rule and blood in the stools is more constant. The carcinomatous mass is more movable, causes no discoloration of the skin and there is no tendency to invade the anterior abdominal wall or to sinus formation. It is usually impossible to remove all the diseased tissue at operation because of the diffuse infiltration. The most that can be done is to drain the abscesses, curette the sinuses and irrigate the area. At the same time large doses of potassium or sodium iodide should be given by mouth and the area in the region of the infection treated by the Röntgen-ray.

Tuberculosis at the ileocæcal region is not uncommon. Fenwick and Dodwell report 85 per cent. of the cases of intestinal tuberculosis as involving the ileocæcal region. The disease may be localized or disseminated. Two forms are described, the ulcerative and the hypertrophic. The ulcerative form may simulate actinomycosis, while the hypertrophic form simulates carcinoma or occasionally appendicitis. The hypertrophic form is by far the more frequent and is characterized by anorexia, intestinal upsets and pain in the right iliac fossa, diarrhœa and constipation, with occasional attacks of partial or complete obstruction. The tumor is hard and somewhat nodular and by

TABLE II

Number	Sex	Age	Diagnosis	Operation	Pathology	Operative result	End result
1415/23	Male	65 yrs.	Carcinoma cæcum	Exploratory 3-9-23	Large mass (carcinoma) in right iliac fossa. Metastasis to bladder wall, mesentery of small bowel; carcinomatous mass near pyloric end of stomach. Primary growth undetermined.	Recovery	Died 4 months after discharge.
2132/23	Male	49 yrs.	Carcinoma cæcum	Resection ileocolostomy, 7-4-23	Hard mass, size of lemon, in cæcum. Piece of omentum adherent to cæcum—excised. Terminal ileum and cæcum resected; ileocolostomy, lateral anastomosis	Recovery	Five months (444). * Feeling well; occasional pain in scar; gain of 26 lbs. since discharge.
549/22	Male	58 yrs.	Carcinoma cæcum	Ileocolostomy, 2-23-22 Hemorrhoidectomy, 3-22-22	Mass in cæcum extending to hepatic flexure. Gall-bladder adherent to mass; stones palpated in gall-bladder Large external hemorrhoids	Recovery	Failed to reply to various inquiries.
1804/21	Male	72 yrs.	Carcinoma cæcum and descending colon	Ileo-sigmoidostomy, 7-12-21	Diffuse carcinoma involving cæcum; small carcinoma involving descending colon	Recovery	Thirty-one mos. (420). Did well for 14 months. Then began to fail. Now has constant diffuse pain in abdomen. Gas passes with difficulty. Colon distended. Sleep and appetite good.

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M. F....	Male	54 yrs.	Carcinoma cæcum	Ileocolostomy. Excision dermoid cyst of transverse mesocolon, 9-19-19	Mass, size of hen's egg removed from mesocolon. Cæcum tied down by mass adhesion at ileocaecal valve, carcinoma	Recovery	No follow-up.†
31/24	Female	39 yrs.	Carcinoma hepatic flexure	Ileocolostomy, 1-4-24	Large growth on hepatic flexure, involving ascending colon. Inoperable. Ileocolostomy, lateral anastomosis	Recovery	.....
2654/22	Male	55 yrs.	Carcinoma ascending colon	Resection and ileocolostomy, 9-11-22	Large hard mass, size of orange on ascending colon. Metastasis to mesenteric lymph-nodes. Six inches of ileum and all of cæcum and ascending colon with part of transverse colon resected. Ileocolostomy, lateral anastomosis	Recovery	Died 12 months after operation
2016/21	Male	48 yrs.	Carcinoma ascending colon	Resection and ileocolostomy, 7-7-21	Annular carcinoma, size of hen's egg on ascending colon, about 5 inches from cæcum. Resection of bowel. Ileocolostomy	Recovery	Did well for 11 months. Then 2 small nodes appeared in incision. Gradual decline. Died 4-22-22 (22 months after operation.)
243/21	Female	50 yrs.	Carcinoma hepatic flexure	Ileosigmoidostomy, 1-4-21	Large hard nodular mass adherent to under surface of liver, involving head of pancreas. Neoplasm of hepatic flexure. Omentum adherent to cæcum, pulling down transverse colon. Ileocolostomy	Recovery	Failed to reply to inquiries.
M. F....	Male	66 yrs.	Carcinoma ascending colon	Ileocolostomy, 8-18-19	Neoplasm on ascending colon. Preliminary ileocolostomy. Secondary operation not performed	Recovery	No follow-up.†

† Follow-up system inaugurated 1920. Cases before that time not followed for this study.

* Patients are rated according to results.

TABLE II—Continued

Number	Sex	Age	Diagnosis	Operation	Pathology	Operative result	End result
S. E....	Male	49 yrs.	Carcinoma ascending colon	Resection and ileocolostomy, 4-3-19	Small intestine distended, ascending colon, distended as far as hepatic flexure. Obstruction at hepatic flexure. Ileocolostomy at middle of transverse colon	Recovery	No follow-up.†
3612/23	Male	37 yrs.	Tbc. cæcum	Cececctomy. Ileocolostomy, 11-14-23	Great omentum adherent to cæcum and parietal peritoneum. Wound enlarged, ileocolostomy	Recovery	Four months (444)*. Wound healed in 2 months No complaints. Bowels regular. Appetite good.
857/22	Female	35 yrs.	Tbc. cæcum and ascending colon. Pregnancy	Exploratory, 3-20-22	Extensive process involving cæcum and ascending colon. Uterus contains 4-months fetus	Recovery	5-1-22 hysterotomy. Seven months improved. Eighteen months operated elsewhere, release of adhesions, of cæcum and obstruction of cæcum and descending colon. Gaining strength (434).
L. G....	Female	22 yrs.	Tbc. cæcum	Ileocolostomy, 1-16-19	Many adhesions about ascending colon too dense for separation, either tbc. or carcinoma	Recovery	No follow-up.*
2331/22	Female	34 yrs.	Tbc. cæcum	Ileojejunosotomy jejunio-jejunosotomy, 8-1-22	Point of obstruction, about 5 cm. long between a distended and collapsed portion of small bowel; lateral anastomosis above distended portion; second anastomosis lower down. Entire jejunum and part of ileum infiltrated by what appears to be a tuberculous process	Recovery	Died one month after discharge.

SURGERY OF THE RIGHT HALF OF THE COLON

palpation may be indistinguishable from carcinoma. Tuberculosis more frequently occurs below the cancer age. The treatment is entirely surgical, consisting of complete removal of the diseased area with a side-to-side or end-to-side anastomosis.

Another lesion of this area requiring surgery is appendiceal fecal fistula. The complication of appendiceal fecal fistula is confined to the cases presenting perforation, abscess and requiring drainage. In the last 4063 cases of appendicitis at the Lankenau Clinic, there were 200 of appendiceal fecal fistula, an incidence of approximately 5 per cent. In every instance more or less pus was present necessitating drainage, and in the vast majority of cases some ulceration of the cæcum or terminal ileum was noted at the time of the primary operation. The cases which had perforated at the base of the appendix displayed the greatest tendency toward the formation of a fistula. Of the 200 fistulæ, 74, or 37 per cent., healed spontaneously, while 97, or 48.5 per cent., required operative repair. The remaining 29, or 14.5 per cent., left the hospital without operation. No doubt a certain proportion of these closed spontaneously. The type of operation for the repair of the fecal fistula depended upon the conditions existent at the time of operation. In 60 per cent. of the cases simple inversion of the fistulous opening by a purse-string linen suture, reinforced by an additional suture line sufficed. In 15 per cent. the condition of the bowel was such as to excite doubt as to its regenerative power in the presence of the fecal stream, so that an added ileocolostomy was performed. In 25 per cent. there were either multiple fistulæ or an opening so large as to preclude closure with maintenance of the lumen of the bowel. These required resection of the bowel varying from a small portion of the cæcum to resection of a foot or more of the terminal ileum with the cæcum and ascending colon. Ileocolostomy was of course the last stage of the operation.

CARCINOMA OF THE COLON*

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THIS report is based on a study of 69 cases of carcinoma of the colon excluding the rectum, treated on the Second Surgical Division of the Roosevelt Hospital since 1909.

The grave character of the disease; the high operative mortality, the frequency of recurrence after resection; the large percentage of cases too advanced to permit of removal when first seen, all tend to make the outlook in these cases far from encouraging.

It is the object of this paper to try to demonstrate the fact that carcinoma of the colon compares favorably with malignant disease elsewhere in percentage of operability and in favorable results both immediate and late, following radical operation.

It is true that many cases first seek surgical advice when the disease is well advanced and beyond hope of surgical cure. Many are first seen in acute obstruction when the diagnosis can only be surmised and emergency colostomy or enterostomy must be resorted to as a life-saving measure. Some of these patients when questioned later give a history of increasing constipation or attacks of partial obstruction, which should have given warning leading to an earlier diagnosis; other attacks come suddenly in patients in apparent good health.

A case now under my care illustrates this type. A woman of fifty had always been well until January of this year when she had an attack of cramp-like abdominal pain attributed to indiscretion in diet which passed off under treatment by catharsis in two or three days. There was no previous history of increasing constipation or abdominal pain, and after the attack the bowels moved normally until a second attack of pain and distention occurring three weeks later, failed to respond to catharsis and enemata, and emergency cæcostomy had to be performed for complete obstruction on February 6, 1924. Radical operation by the two stage, (Mikulicz) method, performed on March 8th, revealed a large carcinoma at the splenic flexure, without glandular metastases or secondary deposits: the lumen of the gut at the growth was barely the size of a lead pencil. She made a good operative recovery.

The first symptom to attract attention may be attacks of colicky pain with abdominal distention, with increasing constipation in the intervals. Careful palpation when the abdomen is flat may reveal a mass, especially when it is located in the cæcum; ascending or transverse colon; the lower end of the descending colon or sigmoid. When at or near the hepatic or splenic flexures it may be difficult or impossible to locate; as it is also in obese or very muscular patients or in the presence of abdominal distention. The discovery of a mass or tumor may be made before any obstructive symptoms have developed or

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other evidence of disease has appeared, or bleeding from the bowel may be the first warning. Bleeding may appear as a single large hemorrhage, as bleeding repeated in moderate amount or as occult blood in the stools. In some cases, especially right colon growths, severe secondary anæmia, debility and loss of weight, may precede local evidence of the disease.

Whatever the initial symptoms may be, a thorough diagnostic investigation should be made at once and the site of the growth located as nearly as possible. When advanced obstruction is present, colostomy or enterostomy must precede this investigation and it is often impossible or unwise to attempt to locate the growth by exploration when this is done. It is far better to do a cæcostomy or ileostomy on the right side than to jeopardize the patient by a difficult exploration in the presence of extreme distention. When the distention is relieved, the abdomen should be carefully palpated for a mass; digital examination of the rectum (a procedure too often omitted) and sigmoidoscopy should be done, and X-ray examination after barium enema, the most valuable of our newer diagnostic methods.

Great care must be taken in interpreting colon radiographs, as apparent filling defects occur from various causes and erroneous conclusions are not infrequent. Differential diagnosis must be made from many other conditions which cause obstruction or abdominal distention.

Obstruction from bands or kinks; from partial volvulus of redundant loops of sigmoid; from impacted fæces in elderly people; distention from paralytic ileus in the course of systemic disease, *e.g.*, pneumonia are all conditions in which we have seen errors of diagnosis made. When the diagnosis has been established and the site of the growth located either by diagnostic examination or exploratory operation, the plan of treatment must be determined.

In many cases the presence of a large, fixed growth; of local extensions or involved lymph-nodes, or of palpable nodules in the liver, make it all too evident that palliative colostomy is the only operation to be considered. In the massive advanced growths without much obstruction it is often wise to omit even this procedure, to avoid the distress and annoyance of a fecal opening during the last few weeks of life.

Sometimes a short circuit operation may be done for obstruction; or it may be justifiable to resect a large painful growth even when nodules are present in the liver, especially when it can be done safely by the two-stage method; for the relief of pain and obstruction. We have done this twice; once in a recent case still under treatment; a large growth at the splenic flexure, without lymph-node involvement or local extension but with multiple nodules in both lobes of the liver. The other case, a descending colon growth with liver involvement, recovered from the operation and was relieved of abdominal symptoms but died 73 days later of cerebral metastases.

Pathologic Types.—There are several gross pathologic types of which the most common are the round ulcer, and the scirrhus contracting growths.

The round ulcer gradually increases in size until if left alone it finally encircles the gut, contracting as it grows and producing as a rule marked

constriction. The growth advances in the submucous layer beyond the limits of the ulcer; the edges are piled up and thickened, not generally undermined, the base is covered with unhealthy granulations which bleed easily. The cases vary in the proportions of cell mass to fibrous tissue, some being quite dense and hard, others spongy and cellular; the latter bleed most easily. While the rate of growth varies greatly, it is often slow, and glandular metastases and the development of secondary deposits in the liver are fortunately often long delayed. It is the type which in the long run offers the best hope of successful eradication.

The scirrhus contracting type is also slow of growth, narrowing the gut lumen as the growth progresses until finally attacks of partial obstruction give warning of its presence, or the narrowed opening may be suddenly plugged with a mass of hardened fecal matter and complete obstruction ensue apparently out of a clear sky. While this type is also of relatively low malignancy with late metastases, not infrequently exceptions to this rule occur in the form of liver nodules, or retroperitoneal gland involvement. The gut above the constriction may be much dilated, and its wall thinned. Rupture above the constriction is possible and we have seen it occur in the cæcum in one of our cases, the result being a huge intra-peritoneal fecal abscess and a fatal issue. In another case a contracting growth in the middle of the transverse colon in which the obstruction had been relieved by an enterostomy in the small intestine, there was absolute water-tight closure of the lumen of the colon at the time of its resection. Bloc resection of the colon with end-to-end suture was followed by spontaneous closure of the fecal opening. Death occurred, however, within a year due to extensive metastases in liver and peritoneum.

When constrictions occur in the ascending colon or cæcum, the lower ileum undergoes hypertrophy and marked dilatation. This often produces the symptom called stiffening of the bowel, or disappearing tumor. The lower ileum goes into a state of tonic contraction similar to that of the gravid uterus; a tense mass formed by the intestinal coils can be seen and felt, and if the hand is kept on the abdomen, in a few moments the spasm relaxes, the gut wall softens and the tumor disappears. This is simply a later phase of the visible peristalsis seen in these cases.

Perforation of the growth itself from deep ulceration, with pericolic abscess formation, occurred in five of our cases; in one the perforation was plugged with an orange seed.

Drainage was done in two cases, a cæcal growth in a woman of seventy-two, and a descending colon growth in a man of forty-four. Simple drainage of the abscess was followed by a fatal result in the cæcal case in twenty-four hours. Drainage of the abscess and cæcostomy by death on the sixth day in the second case. A third case made an operative recovery after drainage of the abscess with a short circuit operation. Two cases died promptly of acute sepsis after radical resection, with contamination of the operative field from the perforation, both left colon cases.

A third type is the massive medullary growth, with early lymph-node

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involvement and metastases. These cases grow more rapidly and are prone to hemorrhage. While attempts at radical resection are usually discouraging in this type, one of our cases, a man twenty-nine years of age, the youngest of the series, lived for three years, four months after operation, an extensive right colon resection and had more than two years of active work in comfort, as principal of a large public school. The growth was of the medullary type with colloid formation; lymph-node involvement quite extensive at the time of operation.

We have had 67 cases of carcinoma of the colon on the Second-Surgical Division of the Roosevelt Hospital since 1909. Of these 37, or 55 per cent., have been treated by radical resection; 19 right colon growths and 18 left colon. Of the right colon growths 17 were resected by one-stage method with immediate suture; 13 side-to-side; 3 end-to-end; 1 end-to-side.

Fifteen of the seventeen recovered and two died; one recent case, end-to-side suture from obstruction at the site of anastomosis, in spite of a secondary enterostomy; the other after the wound had healed and he was out of bed, on the thirty-third day after operation from cardiac decompensation. The operative mortality of this group was 11.7 per cent., or excluding the cardiac death 5.8 per cent. Two right colon cases were resected by the two-stage method; one recovered and one died.

Of the 18 left colon resections, eight were done by one-stage resection with immediate suture; with 3 deaths, all due to acute sepsis, a mortality of 37.5 per cent. Ten were done by the two-stage method with 3 deaths, a mortality of 30 per cent., two were due to acute sepsis; one to late cerebral metastases. The operative mortality of the series, 37 cases with 9 deaths, was 24.3 per cent.

A study of these statistics illustrate the fact that resection of the left colon is attended by a higher mortality than resection of the right colon, in which a one-stage operation with immediate suture is a relatively safe procedure; that the difference is due to the higher infective potency of the left colon content, a fact long recognized, and also to the greater difficulty of securing healing without leakage in suture of the left colon.

These facts are leading us more and more to resort to the two-stage procedure of Mikulicz in left colon growths, and we believe that this procedure will greatly reduce the mortality in this group, in spite of the fact that the results in the short series quoted do not demonstrate this. The real operative mortality in the ten cases so treated, excluding the late death (seventy-third day) from cerebral metastasis, was 20 per cent. rather than 30 per cent., while the mortality, all due to acute sepsis, of the one-stage method was 37.5 per cent.

Three of our right colon cases had severe secondary anæmia when first seen, with the following blood counts:

Hæmcglobin	35 per cent.	R. B. C.	2,914,000
Hæmcglobin	40 per cent.	R. B. C.	3,368,000
Hæmcglobin	46 per cent.	R. B. C.	4,000,000

All were transfused first, and a one-stage entero-colectomy performed, by lateral suture. All made excellent recoveries and are now well at thirteen years, nine years and three years and ten months, respectively.

Right colon growths, even without gross hemorrhage, are prone to produce advanced degrees of secondary anæmia, with great debility, the exact cause of which is somewhat obscure. They offer in spite of this, some of the best prospects for a radical cure as several cases in our series illustrate.

We quite appreciate that the above results are not brilliant, and must turn to late results for a more hopeful view of the prognosis.

Of the 28 cases which recovered from radical resections, 15 are alive and well at the present time without recurrence; one is alive with recurrence at 4 years 4 months after operation. One was well 6½ years and then lost to our follow-up in 1916; one died 8 years after operation, free from recurrence following an operation for septic cholangitis; one 2½ years post-operative free from recurrence, following an extensive resection for persistent colostomy opening; a remarkable and complicated case to which I will refer later.

Seventeen cases out of twenty-eight therefore are well or died free from recurrence after long periods, 60.7 per cent. One lived 6½ years and was lost track of, raising the percentage to 64. One is alive 4 years, 4 months with recurrence.

Of the other late deaths, one followed 6 months after a second radical resection for local recurrence at the ileocolic junction five years after the first operation. One was well 18 months, developed recurrence and died 3 years, 2 months after the primary operation. Seven died of recurrent disease at from 8 to 18 months after operation.

The cases now alive and well are at the following periods after operation: 15 years—one; 13 years—two; 9 years—one; 4 years—three; 2½–3 years—two; 1 year, 10 months—one; 1 year, 5 months—one; 7 months—one; less than 4 months—three.

It is the study of these late results which gives the grain of comfort in the study of cancers of the colon; results which compare very favorably with the results of cancer removal in other parts of the body.

Some of the individual cases present features worthy of mention.

A man seventy-five years of age with a large carcinoma at the splenic flexure and commencing obstruction was resected by the two-stage Mikulicz method, made a good recovery and is now well and free from recurrence at 1 year, 10 months post-operative. He spent all last summer travelling in Europe. Nineteen years before operation a carcinoma of the sigmoid had been resected successfully by another surgeon, and the sigmoid and lower descending colon were entirely free from recurrent growth.

A woman of sixty-five years was operated upon for a transverse colon growth quite adherent posteriorly to a retroperitoneal mass of glands, and thought to be inoperable. A short circuit operation was done between transverse colon distal to the tumor and the ascending colon. Leakage occurred and a wide open fecal fistula developed. After a period of three weeks in which death was expected at any hour she began to improve; later an evaginated protrusion of gut, bearing at its apex a round ulcer type of carcinoma appeared in the fistula and finally protruded so far that the growth with a good length of telescoped gut was cut off; and the ends sutured together. Recovery followed but

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the fecal opening persisted, 2½ years later after insistent demands on the part of the patient, extensive resection was done for cure of the fistula, followed by death from peritonitis on the sixth day. There was no recurrence of the disease. The retroperitoneal invasion noted at the primary operation was evidently an inflammatory mass. This instructive and disappointing case illustrates the well-known fact that adjacent infiltration and gland involvement associated with ulcerated growths, may be inflammatory and not malignant.

SUMMARY

1. Cancer of the colon excluding the rectum offers a relatively high rate of operability, and a percentage of radical cures which compares favorably with that of malignant disease in other organs.
2. Growths of the cæcum, and right colon, including the right part of the transverse colon, are suitable for a one-stage resection with immediate anastomosis by suture. The operative mortality should be relatively low.
3. Left colon growths are more safely resected by the two-stage Mikulicz method.

MULTIPLE PRIMARY MALIGNANT FOCI IN CANCER OF THE COLON*

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DURING a recent study of cancer of the colon carried on in the laboratory of surgical pathology in the Johns Hopkins Hospital, which was reported last spring to this association, there were encountered certain cases of multiple cancers of the intestine. Two of these, with possibly a third, appear to be instances of the development of two or more primary cancers in one individual; two other cases are probably examples of recurrence but with so great a period of time elapsing between the first and second tumors as to introduce an element of uncertainty. The subject has proved of sufficient interest to warrant a brief communication, which is made, be it said, with full realization of the extreme difficulty, often the utter impossibility, of determining convincingly the exact status of any case in this category. In view of the general and well-founded clinical conception of cancer as a condition arising from a single focus of origin but acquiring multiple secondary foci of development, the burden of proof is indeed upon one who assumes a case to illustrate multiplicity of primary malignant tumors, and there are so many possibilities of error in observation and interpretation that one necessarily approaches this subject with extreme reserve.

Five of the 129 cases previously studied form the basis of this report:

CASE I.—S. N., 16588. A white man, aged forty-nine years, was admitted to the Johns Hopkins Hospital, having had for six weeks intermittent colicky pain, and for four weeks a palpable abdominal mass. He had lost forty pounds in weight. Upon exploration there was found an inoperable carcinoma of the cæcum, and an anastomosis was made between the ileum and transverse colon. Symptoms of obstruction persisting, a second exploration was made four days later and revealed a stenosing carcinoma of the sigmoid. Colostomy was without avail, and the patient died following this operation. At autopsy there were found: (1) a large cancer completely encircling the ileum and extending into the lumen so as to produce marked obstruction; (2) a second similar tumor at the cæcum involving the ileocaecal valve and extending around the lumen of the large intestine. This growth was surrounded by a number of polypoid masses and extended deeply into the mesentery; (3) a third tumor, evidently cancerous, surrounding the bowel at the sigmoid flexure. Microscopic examination showed the tumors of the ileum and of the cæcum to be adenocarcinomata of similar histological appearance, both showing a pronounced tendency to invade. The muscular coats had been broken through and the subperitoneal fat invaded; a small lymph-gland lying in the mesentery just below one of the tumors was involved, but otherwise the lymph-glands were negative. The growth of the sigmoid was rather more papillomatous in type, there being practically no invasion of the muscle. The glandular arrangement was preserved throughout this tumor, in some places the alveoli being lined by a single layer of cells and in other places by multiple layers of cells.

* Read before the American Surgical Association, April 17, 1924.

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This case was discussed briefly in 1904 by Bunting,² who remarked that "the author leans toward the view in this case that the foci are independent primary foci." (Figs. 1 and 2.)

CASE II.—S. P. N., 14328. A white man, aged forty-three years, presented a history of constipation for many years, for one year a definite change in the stools and a loss of twenty pounds in weight. Examination disclosed a carcinoma of the rectum 12 cm. from the anal margin. This growth was removed and proved to be a typical adenocarcinoma, with infiltration through the wall of the bowel towards the fat in the hollow of the sacrum. No involved lymph-glands were found. Eight years later the patient suffered an acute intestinal obstruction, and at operation there were found two discrete carcinomata, one in the hepatic flexure and the other in the right part of the transverse colon. That portion of the intestine bearing the growths was successfully resected, the patient dying three months later from an unrelated cause. Pathological examination showed one of this pair of cancers to be typical adenocarcinoma, with marked tendency to form glandular acini, while the other presented a marked histological resemblance to squamous-celled cancer though here and there preserving a slight but definite tendency toward an alveolar arrangement. There were metastases to the lymph-glands at the hepatic flexure. (Figs. 3, 4, 5, 6 and 7.)

CASE III.—S. P. N., 15659. A white man, aged seventy-two years, on the fourth day of an acute obstruction submitted to cæcostomy, dying 36 hours later. At autopsy there were found two annular carcinomata, one at either foot point of the sigmoid. The upper tumor, which was confined to the wall of the bowel, presents so characteristic a histological picture of adenocarcinoma that it could well typify the large majority of cancers of the colon; the lower tumor, which had invaded the mesentery and become adherent to the bladder, presents quite a different picture. It has invaded the muscular coats deeply, and the epithelial cells are throughout closely packed together with very little tendency to take a glandular arrangement. Here and there one recognizes a group of cells with a somewhat alveolar arrangement but in the main this has been lost, even in the advancing edge of the tumor which one sees just beneath the normal mucosa. The lower tumor is apparently

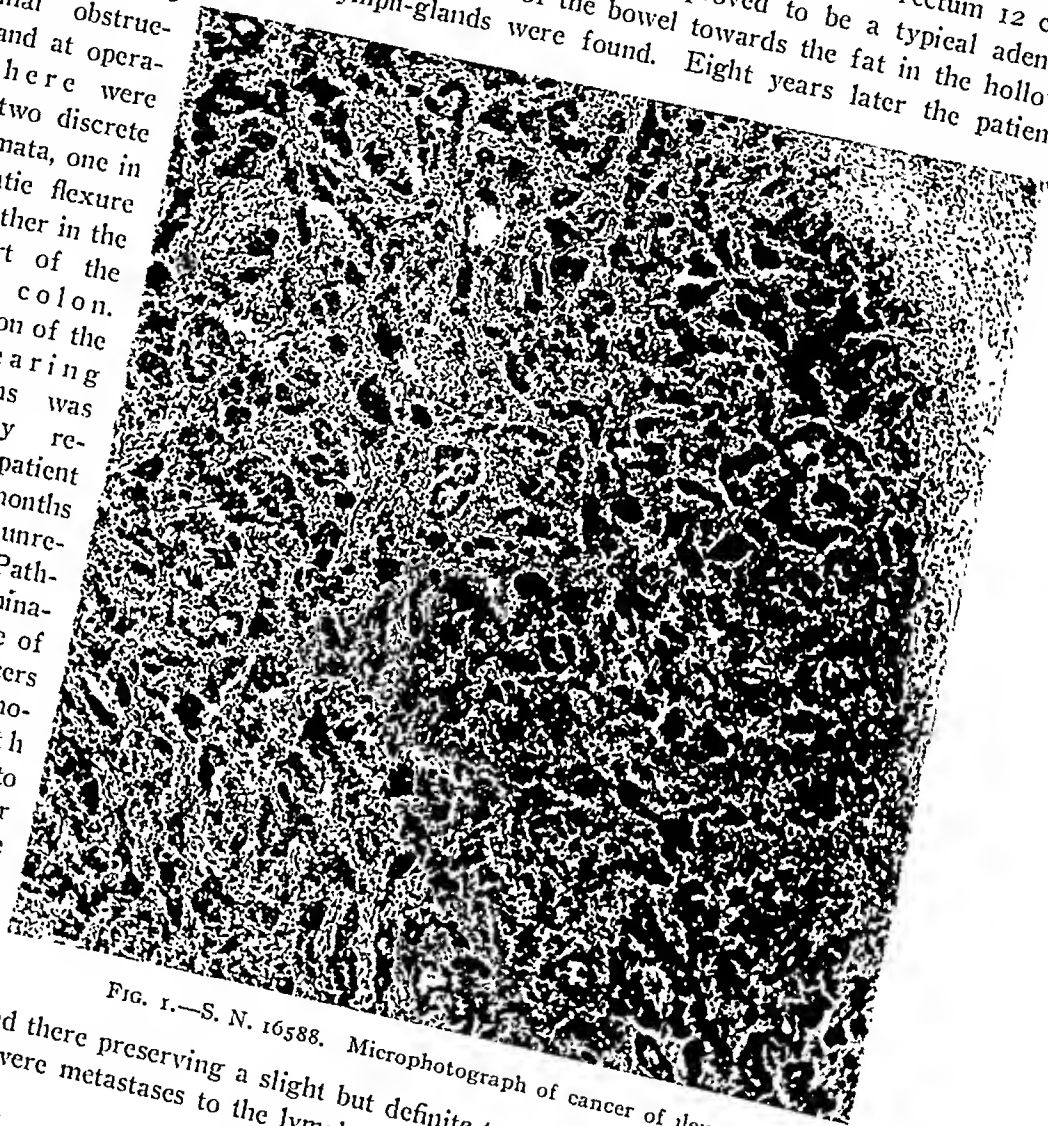


FIG. 1.—S. N. 16588. Microphotograph of cancer of ileum.

somewhat older than its fellow, which is still contained by the muscular coats of the bowel. There are quite marked differences in the histological appearance of the two tumors, and these differences are not readily explained as representing different stages of growth in identical tumors. Both tumors have evidently started in the mucosa; neither represents secondary involvement of the mucosa by extension from a subperitoneal or mesenteric metastasis of the other tumor. These three points are important evidence bearing directly upon the question of multiple primary cancers. (Figs. 8, 9, 10, 11 and 12.)

CASE IV.—S. P. N., 15001. A white man, aged sixty-two years, on the seventh day of an acute intestinal obstruction submitted to cæcostomy. Three months later a cancer of the sigmoid was resected, and on examination found to be a rather fibrous type of



FIG. 2.—S. N. 16588. Microphotograph of cancer of cæcum.

adenocarcinoma producing stricture of the gut. The lymphatic glands were invaded. The patient died seven years later with the clinical signs of cancer of the cæcum involving the abdominal wall at the site of the cæcostomy. Unfortunately no autopsy was made. (Figs. 13 and 14.)

CASE V.—S. P. N., 6595. A white woman, aged thirty-eight years, submitted to exploration because of suspicious symptoms; there was found a carcinoma of the cæcum which was successfully resected. Sixteen years later the patient died; a diag-

nosis of cancer of the liver, though not verified by autopsy, seemed quite secure.

These five cases represent a variety of conditions, but there is common to them all the fact of multiple cancers, which in each instance occur in such fashion as to throw open to reasonable doubt the assumption of a single primary tumor as the sole point of origin of the disease. Such doubt may be aroused by the presence in the intestine of several cancerous foci among which there is great similarity in size, extent of invasion, and apparent age. A similar suspicion is aroused by the occurrence of two or more cancers widely separated by an intervening length of healthy gut, particularly when the aboral tumor appears to be the oldest of the group; if several years intervene between the various tumors and the aboral member of the group is unmistakably the oldest, as in the second instance presented above, the con-

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clusion as to multiplicity can scarcely be avoided. Marked histological differences between the various tumors is difficult to explain other than by their independent

origins. The question of recurrence or a second independent tumor is

usually open and has provoked much argument; under certain

conditions, as marked delay in the appearance of the second tumor, we cannot

hope to arrive at entirely definite

conclusions since either is a possibility and we lack reliable criteria. Thus

the question of multiplicity is raised by each of the five cases and its discussion, even though inconclusive, is not entirely devoid of interest.

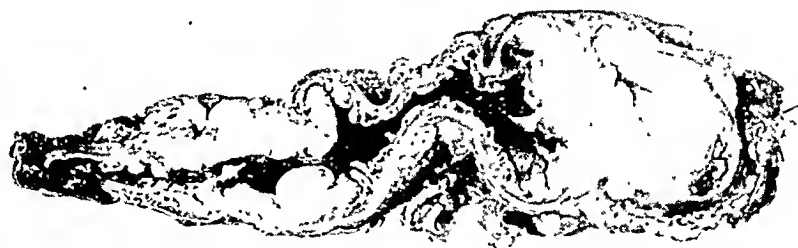


FIG. 3.—S. P. N. 14328. Cancer-bearing sector of colon which was removed at second operation.



FIG. 4.—S. P. N. 14328. Low power microphotograph of the adenocarcinoma. A small portion of normal mucosa is seen at the right end of the section.

The regularity with which cancerous disease takes its origin from a single parent tumor has been so borne in upon us that the occurrence of a case suggesting multiplicity of origin excites a definite interest. The condition has been recognized for many years. Billroth is commonly credited with the first case report, which appeared

in his Manual of General Surgical Pathology in 1860 and told of a cancer of the stomach found in a man from whom an epithelioma of the external ear

had been previously removed. Mercanton³ states that Rokitansky in 1855 and Von Bruns in 1859 both mention the condition and that between 1863 and 1889 the subject was considered by a number of men, among whom are Virchow, Volkmann, Tillmann, and Schimmelbusch. The early reports usually considered multiple cancers of the skin, and it was more or less through the development of this theme that attention was directed toward the other forms of multiplicity. It is probable that multiple primary carcinomatous foci of the skin are associated in the minds of most clinicians with



FIG 5 —S P N 14328 High power microphotograph of the adenocarcinoma showing the preservation of the glandular arrangement.

the dry senile type of eczema and with X-ray dermatitis, but a number of other conditions are mentioned in the same connection, as paraffin and tar cancer, chimney sweeper's cancer of Percival Pott, arsenic cancer, in which a period of pachydermia precedes the development of malignant foci, and the epitheliomata which develop in tissue changed by lupus or psoriasis. v. Hanseman⁴ emphasizes his

belief that only those forms of skin cancer are regularly multiple which are preceded by an inflammatory affection of the skin. With increasing knowledge it became evident that the many examples found in the skin could be conveniently considered together, thus forming one of the clinical groups rather generally adopted at present, *vis.*: primary multiplicity affecting a single organ, the skin and the gastro-intestinal tract being typical examples. Besides this group, there are to-day usually recognized two others, *vis.* primary multiplicity affecting paired organs, and primary multiplicity in which the sites of the several tumors are unrelated. There are many examples of each of these groups.

When two or more carcinomata appear simultaneously it may be less

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difficult to determine their independence of each other than when these tumors appear at intervals of several years, since in the second instance one must distinguish between recurrence and new growth. Distinct histological differences between the two tumors are usually accepted as establishing independence, but it does not necessarily follow that histological similarity means one parent tumor from which the others have sprung; multiple independent carcinomata of the colon developing on a groundwork of polyposis serve well as an illustration. A few years ago a patient sought examination because of a tiny "lump" in the right breast. The suspicious area was so very small that diagnosis other than by microscopic study could not be made, and since there seemed little or no chance of the mass being malignant it was excised under local

anæsthesia. The mass proved to be carcinomatous and radical operation was promptly made. Careful study of the breast in the laboratory revealed a second malignant focus, smaller even than the first, from which it was separated



FIG 6.—S. P. N. 14328. Low power microphotograph of the smaller more solid tumor. Normal mucosa is visible towards the right end of the section. Note the striking difference between this tumor and its companion tumor, Fig. 4.

by a wide area of normal breast. The patient has remained well. Such a case is surely an instance of simultaneous origin of multiple primary malignant foci. For the purpose of argument, however, let us suppose that with the little mass removed nothing more had been done until the second independent cancer, left undisturbed, had grown large enough to be recognized as carcinoma of the breast; under these conditions a clinical diagnosis of recurrent cancer would have been accepted without question. Ellsworth Eliot ⁵ has discussed this subject recently and presented a number of interesting cases. Ewing,⁶ in discussing the influence exerted by tumors upon surrounding tissues as a source of recurrence of the growth, remarks that this question is closely related "to that of the multiple origin of tumors in the same organ."

In the study of this condition, therefore, one must consider the time as well as the site of occurrence. Theilhaber ⁷ states that in point of frequency of occurrence the condition of multiple primary carcinomata takes the following order, *vis.*: (1) local disease which affects one system only, as the

gastro-intestinal tract, and usually but a part of that, as the colon; (2) disease of similar paired organs; (3) synchronous widely separated foci of disease; and (4) widely separated foci of disease appearing at reasonably long intervals.

Early in the study of these cases Billroth formulated three conditions which he thought must be fulfilled by multiple cancers before the different tumors can be considered independent of each other; namely: (1) the two growths must show distinct histological differences and these must be so

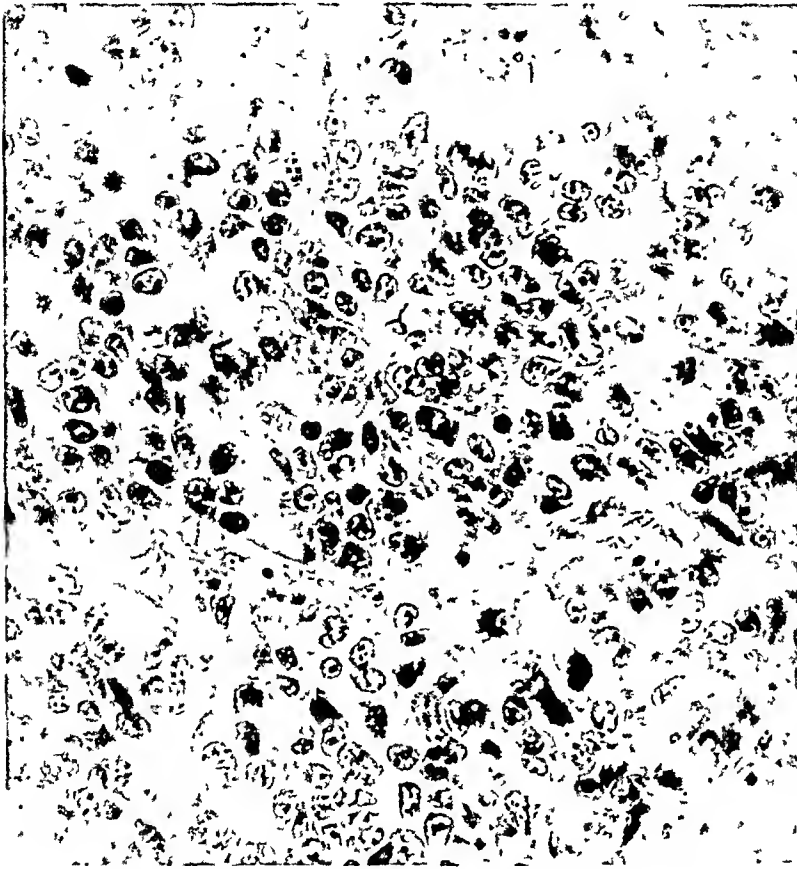


FIG. 7.—S P N 14328. High power microphotograph of tumor shown in Fig 6. Note the great difference between this section and Fig. 5, its companion tumor.

pronounced as to exclude their interpretation as merely different stages of development; (2) each growth must spring from its parent epithelium; (3) each growth must have its own group of metastases. Mercanton attributes these criteria to Michelsohn and Küster, but he apparently is alone in failing to credit them to Billroth. It is obvious that simultaneous tumors

which fulfil each of these three conditions would have very strong evidence of their independence of each other. Mercanton adds a fourth condition to the effect that if, after the removal at one operation of two cancers, the patient remains free from disease, it is practically certain that the two growths were independent, since had either been a metastasis it would be entirely reasonable to assume the presence of other metastases, a state of affairs incompatible with life. This fourth condition appears sound and is applicable particularly to multiple cancer of the colon and similar examples where the growths are confined to one relatively small organ. There are apparently unquestioned instances of multiple primary cancers of the colon, and it is evident that such

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a case may not fulfill Billroth's three conditions; Bunting is of the opinion that these criteria were obviously intended to apply to carcinomata arising in different organs. Surely any group of simultaneous lesions which fulfill all of these conditions would be beyond doubt. Indeed it seems quite safe to accept certain cases which fail to meet all of them. Arbitrary insistence is unreasonable; common sense recognizes, probably without argument, the primary multiplicity of adenocarcinomata of the colon which starts in polyps. There is much

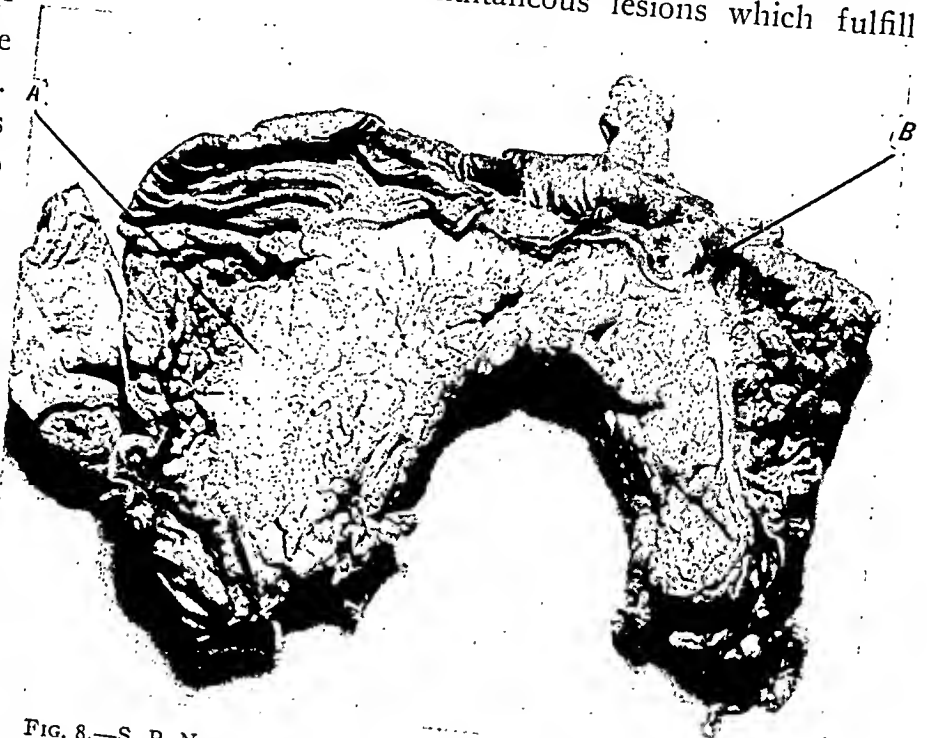


FIG. 8.—S. P. N. 15059. Longitudinal section through the sigmoid loop and its mesentery. The mucosa is shown above and the mesentery below. Two cancers present in the lumen of the bowel, that at A being the larger tumor and preserving its adenocarcinomatous structure, that at B being a smaller and more fibrous tumor.

in the literature indicating that a colon which is the site of multiple polyps is prone to present cancerous changes in certain of them, so that whether

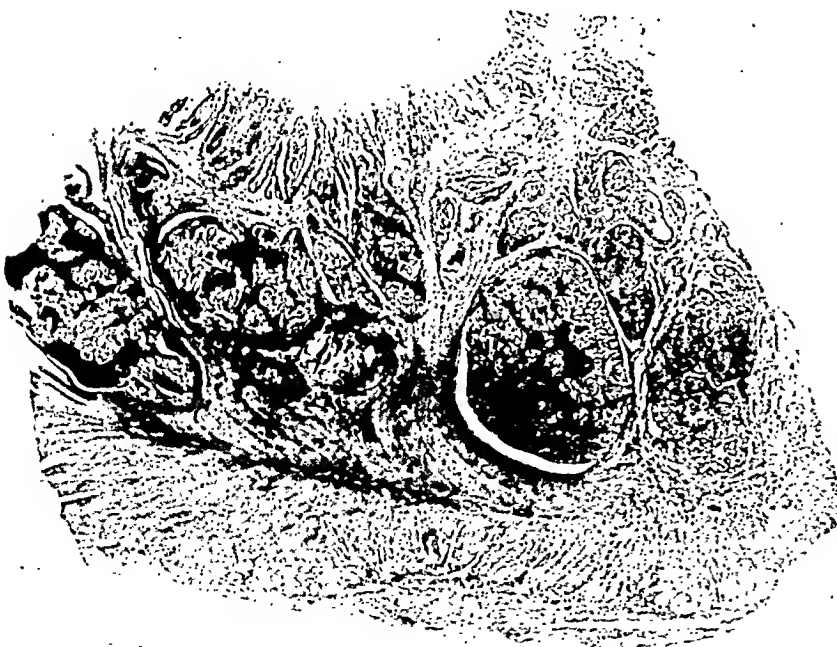


FIG. 9.—S. P. N. 15059. Low power microphotograph of tumor A.

these tumors appear simultaneously or, as in our second case, spaced by several years, one can hardly doubt the nature of the condition. Figure 15 shows this not infrequent finding, viz.: cancer and polyp in close association. (Figs. 15, 16, 17.) In the gastro-intestinal tract, however, there are a num-

ber of ways in which a secondary dependent growth may become established, so that our problem is often very difficult. We recognize metastasis by the lymphatics; commonly we think of this as occurring by a path leading directly and consistently away from the tumor, but there is always the possibility of metastasis by retrograde or other circuitous routes. It may be a matter of the utmost difficulty, indeed impossible, to assert concerning two cancers of the gastrointestinal tract that each is a primary neoplastic unit quite independent of its companion tumor. Our case of double cancer of the sigmoid presents just this problem. This patient was brought to the hospital in acute obstruction



FIG. 10.—S. P. N. 15059. High power microphotograph of tumor A. Note the preservation of the glandular arrangement.

of the sudden unheralded type. Colostomy failed to rescue the patient, and at autopsy there were found two cancers, one at either foot point of the sigmoid. One was confined to the wall of the bowel, the other had begun to penetrate it. The growths were not in contact nor were there any visible lymphatic strands connecting them; they were approximately of the same size, from which one may

infer their approximately equal length of life. Under these circumstances there exists at least the possibility of their simultaneous development. It is similarly possible, however, that lymphatic metastasis has occurred by way of the mesentery, travelling first upward to its root, and then, perhaps because continued progress was blocked in this direction, down to the other foot point of the sigmoid. Had this occurred early in the disease the final picture might simulate double primary cancer closely. Were a case such as this to fulfill the three conditions of Billroth one would be inclined to accept the primary multiplicity of the carcinomata as proved; it must be recognized, however, that failure to meet the conditions does not necessarily throw the case out. The possibility

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of the occurrence of primary multiple carcinomata which do not fulfill Billroth's conditions cannot be denied.

We recognize the occasional transmission of cancer also by the blood stream, it even being held that retrograde venous embolism may occur. There is also the establishment of a second cancerous focus through contact; certain cases in the literature illustrate the transmission of cancer from one to the other lip or from the tongue to the cheek. In the gastro-intestinal tract this condition usually brings about the adherence of one organ to the other, the final appearance being that of direct extension of cancer in continuity. Dissemination through the escape of cancerous cells which float off in the peritoneal fluid is

well recognized.

Such secondary growths are frequently found in the pelvic parietal peritoneum, and their occurrence is not infrequent upon the visceral peritoneum, particularly of the omentum and the mesentery. We assume this to be a late phenomenon resulting usually in a multitude

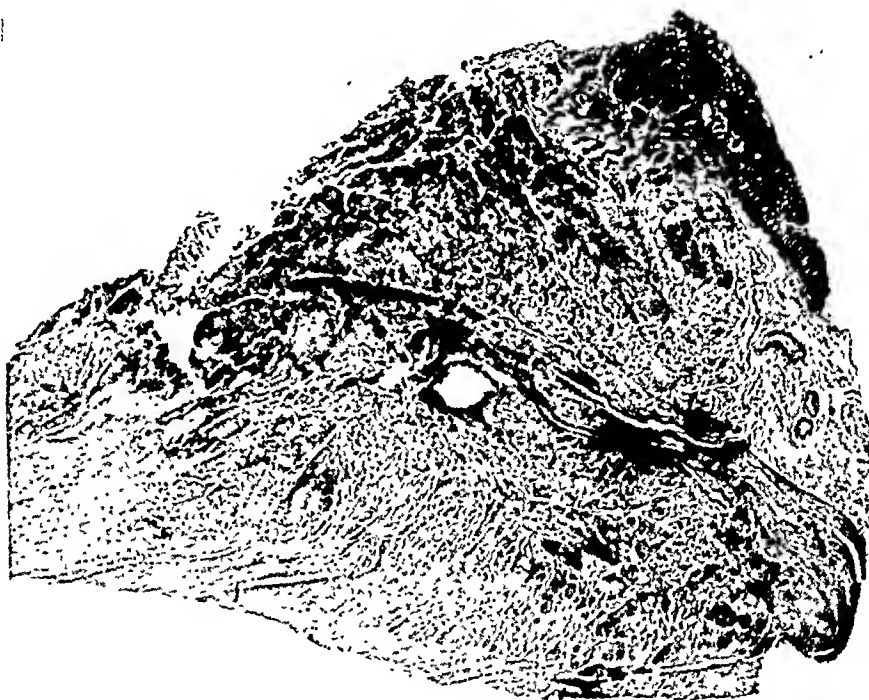


FIG. 11.—S. P. N. 15059. Low power microphotograph of tumor B.

of small obviously secondary growths, so that simulation of but two or three primary carcinomata could hardly result.

There is an implantation type of cancer in the gastro-intestinal tract which is of very considerable interest. Indeed, this mode of transmission is usually held to account satisfactorily for multiple carcinomata presenting in the lumen, and is so obvious that it is difficult to avoid its acceptance when the growths are of similar histological type and so situated as to indicate that the aboral member is the youngest of the group. However, when a prolonged period of time separates the appearance of the two tumors and the second lies orally with reference to the first, as is illustrated in the second of the cases cited above, implantation or engrafted cancer fails to explain the situation satisfactorily. A striking example of implantation cancer of the gastro-intestinal tract is reported by L. Hoche⁸ in *La Presse médicale* of 1901 and is of sufficient interest to warrant its statement in detail.

A man of seventy-five years died from cachexia twelve hours after admission to the hospital. At autopsy there was found an epithelioma of the œsophagus 4 x 2.5 cm, situated 5 cm. above the bifurcation of the trachea. The lesser curvature of the stomach was adherent to the pancreas, and upon opening the stomach there was found in this situation a chronic ulcer the size of a two-franc piece. On the base of the ulcer was a hard nodule which was not in contact with the epithelial edge of the ulcer at any point and which, though more or less imbedded in the pancreas, was quite distinct from it. Histologically the nodule proved to be a discrete, sharply outlined cancerous mass which did not invade the pancreas. The base of the ulcer was otherwise composed of

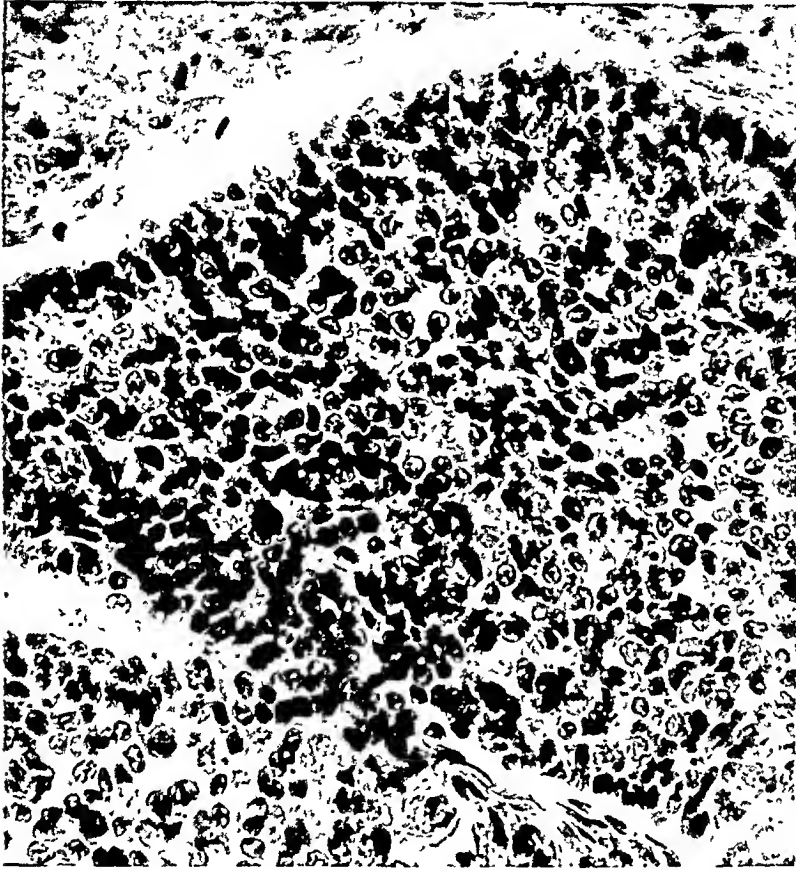


FIG. 12.—S. P. N. 15059. High power microphotograph of tumor B. Note the closely packed epithelial cells, strongly suggesting squamous cell cancer. There is a striking difference in appearance between this tumor and that shown in Fig. 10.

granulation tissue, and its epithelial edges showed nothing more than simple inflammation. The pancreas likewise showed only simple inflammatory changes. The lesion was apparently a simple ulcer in whose centre there had developed a cancer which entirely lacked contact with normal epithelium at any point. The growth in the œsophagus (Fig. 18)[†] was found to be a typical squamous epithelioma whose histological picture was duplicated by the carcinomatous nodule in the base of the ulcer (Fig. 19).[†] Nothing was found to suggest

the usual adenocarcinoma of the stomach. No other cancerous lesions were found.

Another interesting example of engrafting of cancer was reported by Chalier^a in 1909. A man of forty-three came to autopsy some months after an anastomosis between the ileum and the transverse colon had been made to relieve him of partial obstruction due to a cancer of the cæcum. There were found (1) in the ileum 10 cm. from its termination three or four submucous nodules as large as a small chestnut, (2) in the cæcum an ulcerating cancer of the ileocecal valve, (3) a stenosing cancer at the junction of cæcum and ascending colon, and (4) in the transverse colon thick sclerotic cancerous tissue surrounding the anastomosis. Histologically the growths were all colloid cancer. Chalier remarks that the growth in the transverse colon is definitely an implanted

[†] Reproduced from article by Hoche in *La Presse médicale*, 1901, vol. i, pp. 67-69.

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cancer since it occurs in tissues which were quite healthy at time of operation but which suffered both operative trauma and the scarring incident to healing. One can well imagine that implantation occurred upon some granulating area before the healing process had been completed. Dowden¹⁰ in 1917 Reported a case of much the same sort. The patient was a woman of sixty years who submitted to three operations: (1) resection of a cancer of the sigmoid, fol-

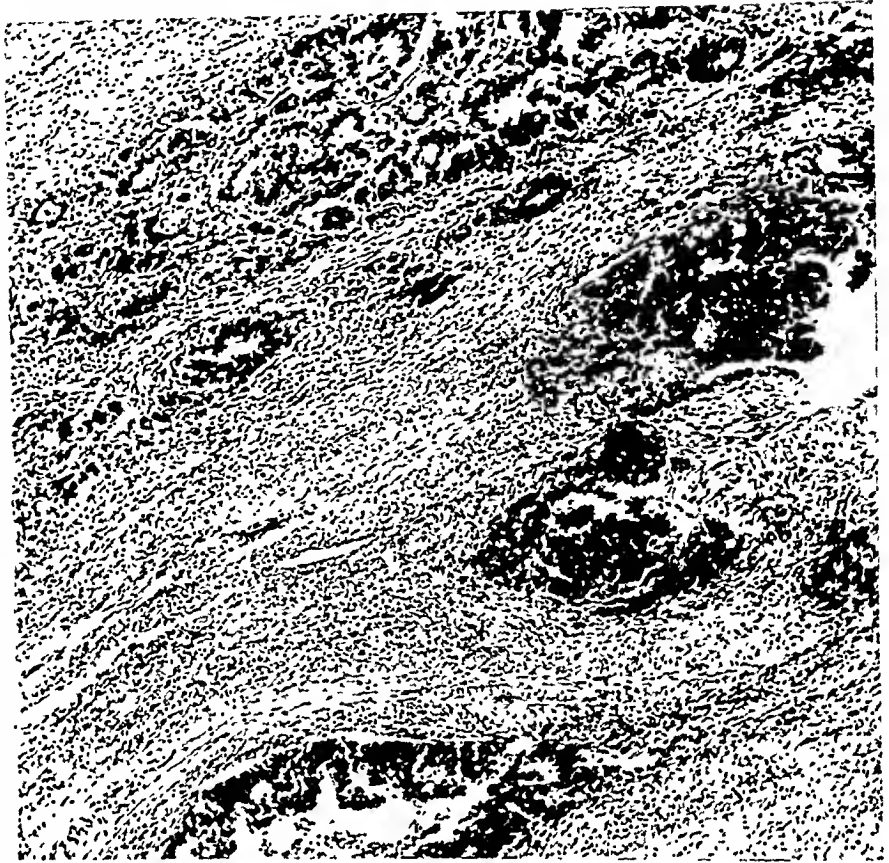


FIG. 13.—S. P. N. 15001. Cancer of the sigmoid.



FIG. 14.—S. P. N. 15001. Metastasis to adjoining lymphatic glands.

lowed in three years by (2) colostomy for cancer of the rectum, and at the end of a year (3) resection of a cancer of the small bowel. A few months after the final operation cancer appeared at the colostomy wound. Dowden believed the disease to have been primary in the ileum. Recurrence or the development of a second cancer in the traumatized tissue of an old colostomy is shown in our case Number 4; here, however, there can hardly have been a question of implantation since the first tumor was in the sigmoid and the second in the cæcum. Christian Fenger¹¹ in 1888 reported a case which may be in-

terpreted as double primary cancer of the colon or as an example of implantation. It concerns a man of about forty-five upon whom an anastomosis between the ileum and

the transverse colon was made for cancer of the ascending colon. At autopsy made ten days later there was found a cancer of the ascending colon, producing complete obstruction, and a second cancer of the splenic flexure, causing marked stenosis.



FIG. 15.—S. P. N. 27377. The cæcum has been opened to show the mucous surface. There is seen a large adenocarcinoma at whose edge (to the right) is situated a benign polyp.

There appears to be no doubt as to the occurrence of implantation cancer of the

mucous surface of the gut, and of all the forms of secondary growth, apparently cancer so produced may most clearly simulate primary cancer.

This is particularly true when the growths are limited to a small section of the gut, as for instance the colon. Practically all cancers of the colon, whether primary or secondary, are assumed to preserve an adenocarcinomatous structure in a more or less marked form, so that a widely different histological appearance in the two growths is not

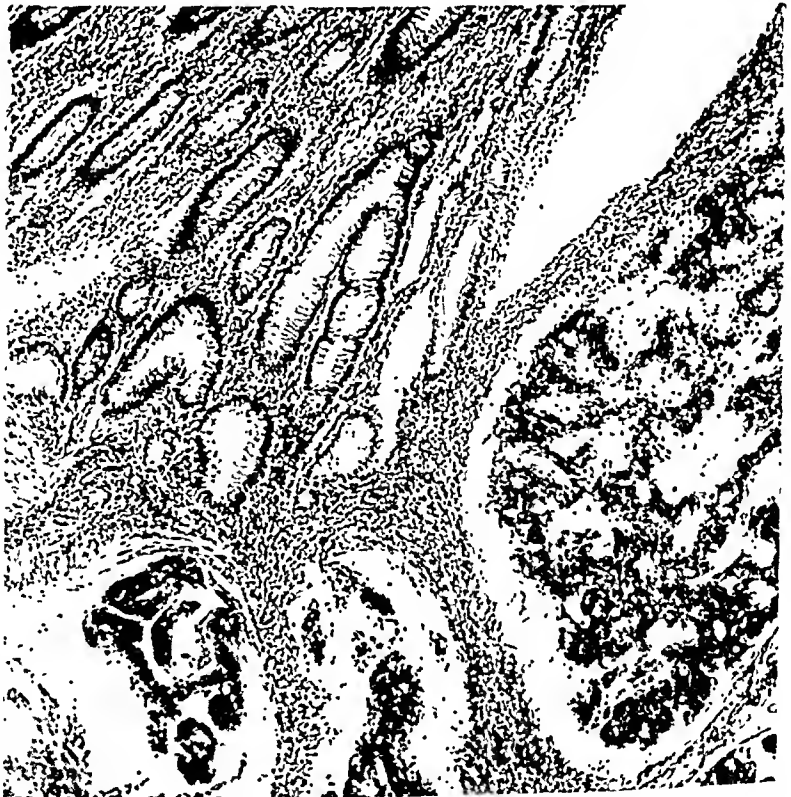


FIG. 16.—S. P. N. 27377. Microphotograph of adenocarcinoma in Fig. 15.

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expected. They all spring from epithelium of the same type—the mucosa of the large gut—and in general all would tend to produce metastases of the same type, though in different situations.

A much more fundamental question, indeed, has been raised from time to time as to whether the lesion diagnosed clinically as cancer has in fact started in and grown from one centre or whether its unity does not rather mean that since the process started, enough time has elapsed to allow coalescence by growth of multiple centres of origin, thus converting actual multicentric growth into apparent unicentric growth. This carries the question beyond the limits of clinical study; diagnoses from physical signs cannot be made in such early stages of disease.

The foregoing discussion makes no pretense of attempting more than a brief résumé of the subject together with the presentation of several cases which illustrate certain aspects of the problems of the genesis

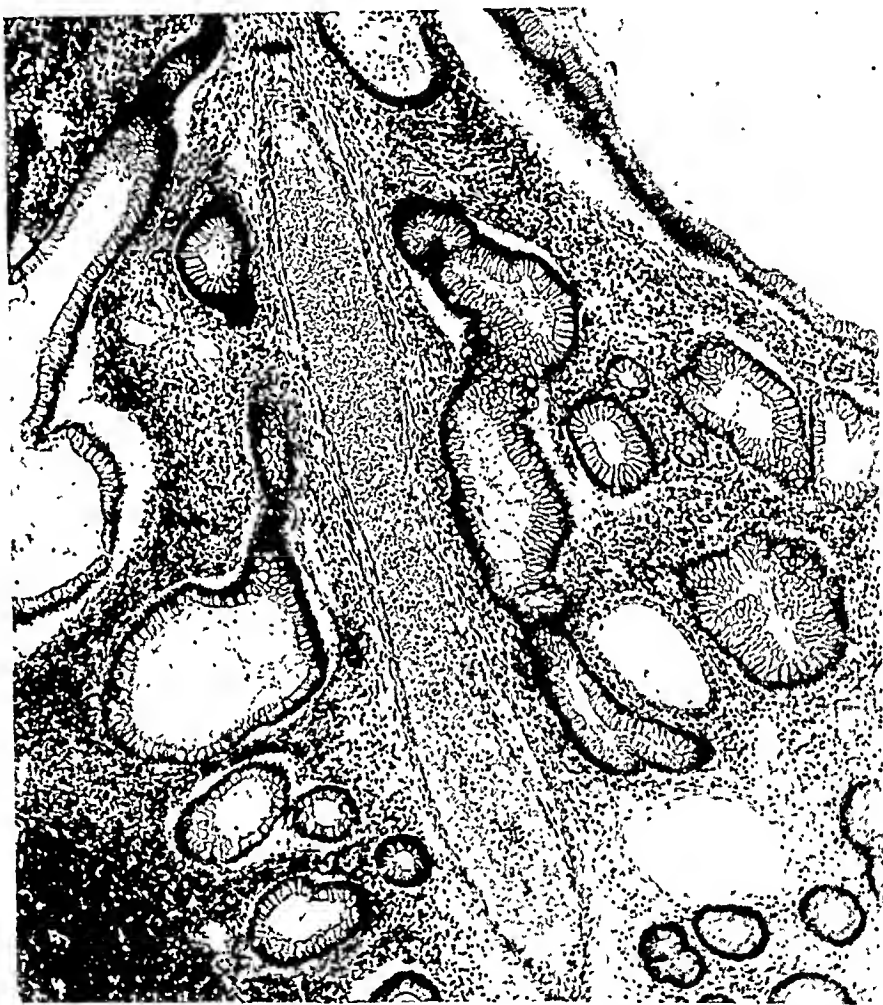


FIG. 17.—S. P. N. 27377. Microphotograph of benign polyp in Fig. 15.

and the growth of cancer. Although the matter appears to be largely of speculative interest, its consideration nevertheless brings out certain facts of some importance in the management of cancer of the colon. It must be recognized that there occur certain rare cases in which cancer of the colon starts in two or more primary foci. The terminal ileum is not uncommonly associated with the colon in this type of disease. Exploration of the ileum and entire colon should therefore be a routine step in the operative treatment; experienced surgeons have closed the abdomen without suspecting the presence of the second tumor. A growth of the splenic flexure is peculiarly elusive.

By a process of implantation secondary cancers may be engrafted on the mucous surface of the colon or elsewhere in the gastro-intestinal tract, and

it appears that traumatized tissue is an especially fertile bed for this development; such an occurrence is not rare and may result in a condition offering

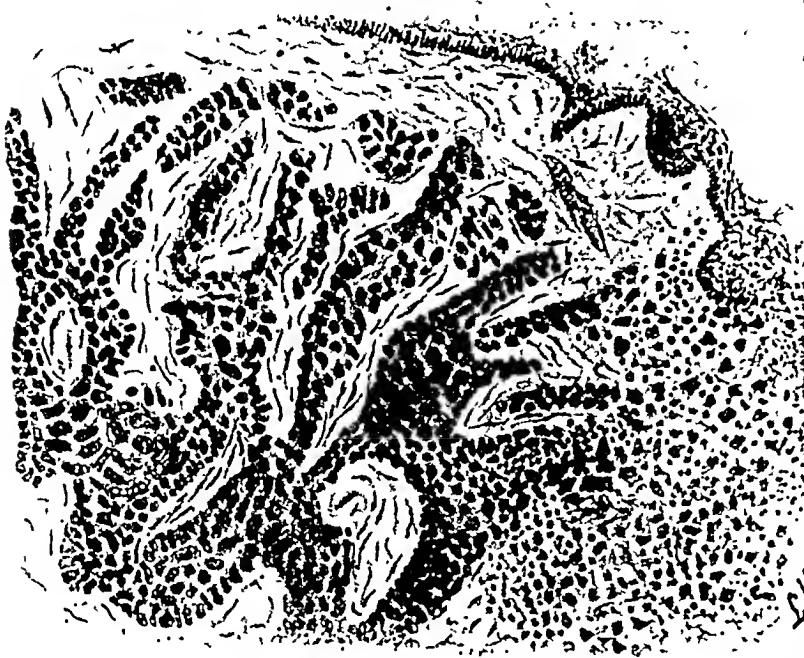


FIG. 18.—Section taken on the edge of the ulcerated tumor of the œsophagus. (Reproduced from article by Hoche.)

a polyp of the colon. There are numerous records of the association of polyposis and cancer; there may be found a cancer and a polyp side by side, as pictured above,

or in a colon bearing numerous polyps there may be found two or more cancers apparently of approximately the same age. In the literature there are reports of cases, like our second case, in which two or more cancers develop one after the other and separated by intervals of several years. The

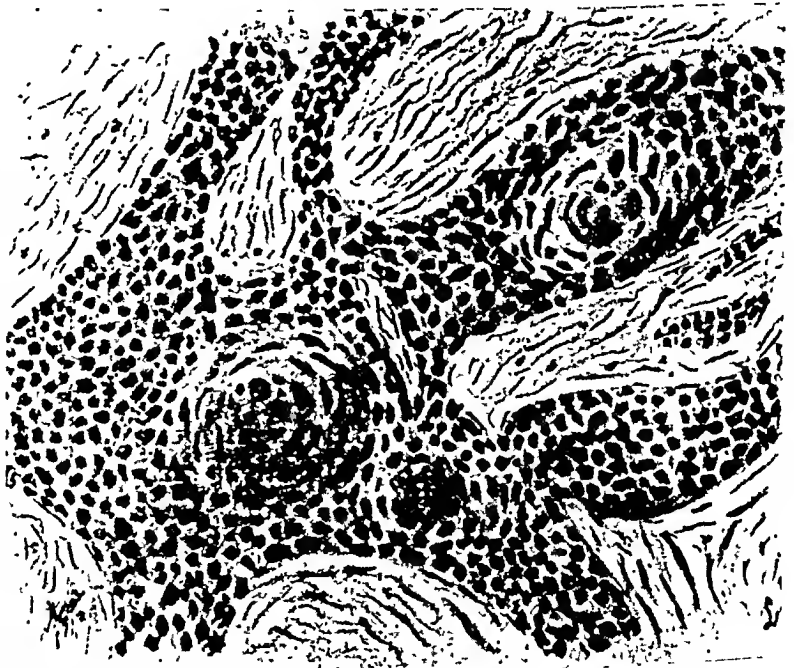


FIG. 19.—Section taken in the neighborhood of the base of the gastric ulcer. (Reproduced from article by Hoche.)

the same surgical problems as multiple primary tumors. Adenocarcinoma, the common type of cancer of the colon, seems especially apt to develop secondary implantation growths.

Clinical experience and many reports in the literature make it plain that carcinoma is prone to develop in the mucosa of

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first tumor is apt to be in the lower colon and the others to occupy sites progressively higher, which excludes the possibility of implantation. The time interval between the appearance of the tumors is too long to encourage their interpretation as delayed recurrences even were their sites of development to favor this explanation. The tumors start on the mucosal surface and frequently do not penetrate the bowel wall deeply, which excludes metastasis by the blood or lymph stream or peritoneal fluid. Finally, in such a colon polyps are very apt to be found, and their known tendency to carcinomatous change seems to offer adequate explanation of the circumstances of such a case.

Appreciation of the surgical problems of polyposis of the colon is, then, of very considerable importance to the surgeon. This matter has been discussed more or less in the literature, but recognition of the cancer tendency in polyposis of the colon is of relatively recent date. The subject has been discussed by Babler, Niebruegge, and Fisch,¹² Lilienthal,¹³ Lockhart-Mummery,¹⁴ Bardenheuer,¹⁵ Back,¹⁶ and Forster.¹⁷ It is a benign condition with definite carcinomatous tendencies—in other words, a clear precancerous lesion—and this fact will perhaps largely determine our final position with reference to treatment. At present there is no generally accepted plan and the suggestions have ranged from simple excision of the polyps to complete colectomy, which, radical though it seems to-day, may yet come into quite general usage. This subject would well repay careful study.

In a practical sense, then, we must recognize that cancer of the colon may occur as multiple primary lesions, that an entirely similar picture may be produced by tumors which develop secondarily, and that polyposis of the colon has a very definite tendency to malignant degeneration.

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simple precaution we have now found that shadows may be obtained with the relatively soluble sodium salt which are just as satisfactory as those formerly obtained with the less soluble calcium salt. The presence of calcium, therefore, seems to be of no particular value. The additional advantage is also present that, instead of the necessity of using about 325 c.c. of fluid, as was the case with the calcium salt, in order to give the usual dose of 5 or 5.5 grams of the salt, it is necessary to use only about 35 or 40 c.c. of water to effect the solution of the 5 or 5.5 grams of the sodium salt. The unpleasant



FIG 2.—The same after 24 hours. The shadow has become much more distinct and the gall-bladder is much smaller. The contour is regular.

symptoms following the injection have also been greatly diminished as a result of the use of the smaller amount of fluid injected. For these reasons, therefore, we are now using the sodium salt exclusively.

It is hoped that the method of visualization of the gall-bladder described here may have a distinct clinical value in the diagnosis of certain cases presenting abnormalities of the biliary tract which would otherwise be obscure, in a manner analogous to the revolutionary effect of the opaque meal in the diagnosis of gastrointestinal conditions.

Aside from this effect, however, the method may also prove to be of value as a test of the functional capacity of the liver, as judged, for example, by the time required for the appearance of the shadow. It will also permit the addition of new facts to the store of knowledge of the normal physiology of the gall-bladder, especially as regards the question of emptying time, etc.

The theory of the action of the substance, and the theory upon which the work was based, is that, if a substance which is opaque to the Röntgen-ray would be excreted into the gall-bladder by means of the bile, a shadow should be produced which would permit an accurate visualization of the gall-bladder. It is necessary therefore (1) that the functional capacity of the liver be sufficient to permit it to secrete the substance in the bile, (2) that the cystic duct be open to permit the substance to enter the gall-bladder and (3) that the concentrating function of the gall-bladder be sufficiently good to permit con-

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centration of the substance in the gall-bladder. Theoretically, therefore, we should expect that the best shadows should be obtained with normal gall-bladders and that a failure to obtain any shadow at all, after following out the technic given below, would almost certainly denote serious pathology of the biliary tract, including the gall-bladder. Our experience has borne out the above prophesy.

We have injected either the calcium or the lithium salt now in fifty or individual cases, in addition to a large number of experimental animals. In four cases we have failed to obtain any shadow, but in all of these operation revealed very definite cholecystitis. In two of the seven cases there was a complete obstruction of the cystic duct by stone, and in one case there was only a fibrous remnant of a gall-bladder associated with a stone in the common duct. We feel, therefore, that the failure to obtain a definite shadow when the test has been carried out properly is of great value as probably indicating a high grade cholecystitis. We have also been able to diagnose gall-stones in several instances, which have shown themselves to be less opaque areas in contrast with the heavier shadow of the rest of the gall-bladder. Adhe-

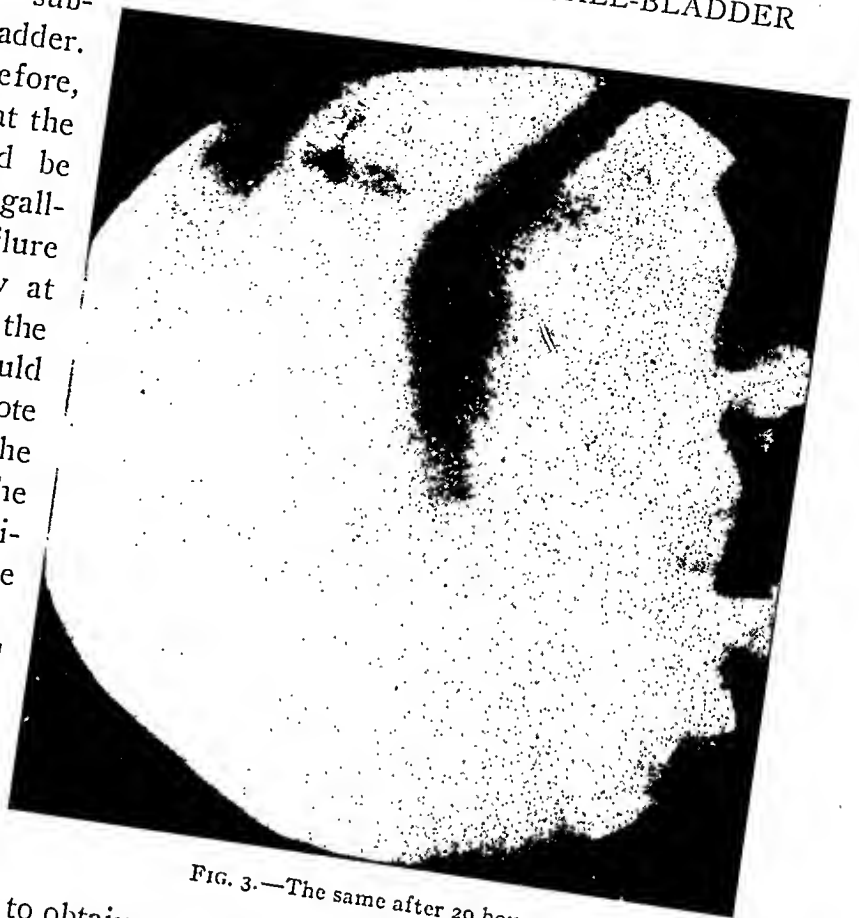


FIG. 3.—The same after 29 hours.

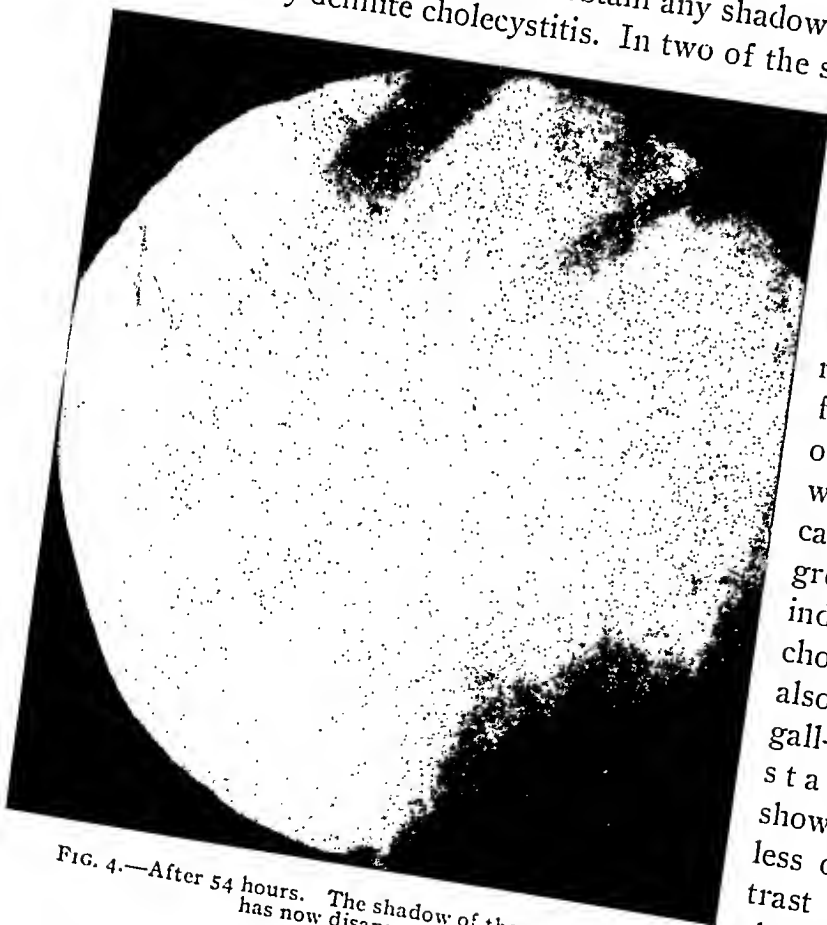


FIG. 4.—After 54 hours. The shadow of the gall-bladder has now disappeared.

sions, too, have been recognized by the distortions of the normal contour of the wall of the gall-bladder.

In order to be sure of the results it is very essential that a series of plates shall be made, taken at intervals during a period of about thirty-six hours. The interpretation of the normal gall-bladder is based upon the following findings: Usually at about the fourth to the seventh hour after the injection a faint but definite outline of the gall-bladder appears which is seen to have the contour of the normally shaped organ but to be somewhat larger than normal gall-bladders usually seen at laparotomy. At the end of twenty-four

hours the shadow is much more distinct but contracted down to only about one-half of its earlier size. From then on until about the forty-eighth hour the shadow diminishes in size and fades gradually. In cases of simple cholecystitis without stones or adhesions the appearance of the shadow may be delayed and it may be much less dense than the normal. At the present time, however, the interpretation of abnormal shadows is not yet on a secure foundation. A greater experience will be required to work out the interpretations satisfactorily.



FIG. 5.—A gall-bladder showing distortion by adhesions.

Technic.—Injection of the sodium salt is very easily done with a syringe; preferably in two doses one-half hour apart. We have not given it all in one dose and do not know if any deleterious results would follow. Much better results are obtained if the injection is made in the morning between 7.30 and 9.30 A.M., before breakfast.

Crystals of the sodium salt of tetrabromphenolphthalein may be obtained from the Mallinckrodt Chemical Works of Saint Louis. The crystals dissolve very readily, especially upon heating. After filtering, the solution may be sterilized in a boiling water bath for 15 or 20 minutes or in an autoclave. If Mallinckrodt's crystalline sodium salt is used, the solution is prepared by adding about 40 c.c. distilled water to $5\frac{1}{2}$ grams of the sodium salt. It is ready for injection after filtration and sterilization. If the patient weighs less than 120 pounds, the dose should be reduced accordingly; great care

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must be exercised not to allow extravasation of the solution into the tissues of the arm. To avoid this possibility the needle should be first inserted into the vein before the syringe containing the material is attached. After completing the injection, it is well also to run a little saline solution through the needle.

Orders for the patient:

1. Omit breakfast.
2. Omit lunch (may have glass of milk).
3. Lie on right side of abdomen or be up walking around.
4. Omit proteins from evening meal.
5. May have water by mouth.
6. Sodium bicarbonate, grs. XL, every three hours for 48 hours.

Röntgenograms are taken at 4, 8, 24 and 32 hours. The only toxic effects which have so far been discovered with the dose recommended have been temporary and have shown themselves as dizziness, nausea and vomiting. No changes have appeared in the urine. For some unexplained reason male patients are less susceptible to the toxic effects than female patients. Many patients have no disturbance of any kind.

CLOSURE OF ARTIFICIAL ANUS OF EIGHT YEARS' DURATION, WITH SOME REMARKS ON THE QUESTION OF INTESTINAL ANASTOMOSIS*

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INSTANCES of the closure of an artificial anus of more than one years' duration are obviously rare. During that interval no material depreciation in the function of the intestine below the abnormal orifice has taken place. The closure of the opening leads immediately to the complete restoration of colonic action. On the other hand, in cases of long standing, in which the entire bowel contents are discharged through the artificial anus, it is quite reasonable to infer that, owing to the disuse extending over a period of years, the motor, vascular, secretory and nervous apparatus of the intestinal wall may have become so atrophied or otherwise changed that even a partial restoration of their several functions may not take place when the abnormal orifice is closed.

In 1913, the writer was asked to see a patient who had developed an artificial anus following an operation for the relief of an infected appendix. As a fecal fistula, especially where the appendix at the junction with the cæcum happens to be gangrenous, is not a rare post-operative complication and as these fistulæ usually close spontaneously in the course of ten days to several weeks, conservative measures were advised notwithstanding that the entire bowel contents passed through the artificial opening. As the condition remained unchanged at the end of a year, a second consultation was held to discuss the propriety of operation. The patient, about sixty years of age, had for many years been an incurable paranoiac and required the constant attention of two nurses whose testimony, together with that of the attending physician, conclusively showed that the occasional fecal discharge through the abnormal opening did not cause the slightest perceptible annoyance or discomfort and that the usual prophylaxis prevented any irritation of the adjacent skin. Furthermore, the relatively low position of the opening precluded any deterioration in the patient's general condition. While closure would unquestionably have been attempted in an otherwise normal subject, the fact that such a procedure, if successful, would, in the case of an incurable paranoiac, have neither added to her comfort nor have removed the need of constant nursing, seemed to justify a laissez-faire policy. This conclusion was still further strengthened by the surmise that a marked decrease in reparative power, due to the long-continued mental derangement, would, if present, unfavorably affect the chance of successful closure if it did not actually predispose to a fatal post-operative peritonitis.

After several years prolapse appeared. This at first was slight and easily controlled by an overlying pad, although it gradually increased in size. After a time, however, the prolapse, always reducible, became more complete until finally, seven years after the original operation, it formed a voluminous mass, balloon-shaped, bulging over the side of the patient for a distance of at least 12 inches, consisting evidently of the entire ascending colon. When reduced every contrivance failed to prevent its spontaneous return. In this condition it became both a source of annoyance and irritation and its resection seemed justifiable provided that the capacity of the distal gut to function could

* Read before the American Surgical Association, April 17, 1924.

be established with reasonable certainty. Would the delicate nervous, secretory, vascular and muscular mechanisms of the wall of the large intestine, after so many years of inactivity respond to the stimulus of intestinal contents and conduct them by their successful coördination through the entire length of the large intestine to and through the rectal outlet?

Digital examination disclosed a tonic rectal sphincter. Enemata were expelled, the first with a considerable discharge of mucus and faeces, the first in seven years. A small quantity of an analine dye, administered under low pressure in a colon irrigation, appeared at the artificial anus. The operation, as suggested, was therefore performed, the terminal ileum, the entire ascending and several inches of the transverse colon being resected through an incision inclosing the former operative scar and the artificial anus, followed by a lateral anastomosis. The wound was closed in layers around a protruding drain. The patient stood the operation well. The temperature, never above 100, was normal on the fourth day. There was no distention at any time. Peristalsis was quickly reestablished, gas being passed per rectum at the end of the first 24 hours. The bowels moved naturally on the second day without enema or drip. For the first week the bowel movement were fluid and occurred on an average of once every four hours. The buttocks became considerably excoriated, necessitating constant watching. A small occasional dose of morphine lessened the frequency. The first formed movement occurred one week after operation and afterward the consistency varied. The patient took fluids and soft nourishment with relish. The superficial wound became infected with some sloughing of the aponeurosis. A persistent sinus remained.

During the past four years the patient's condition has been satisfactory, although the post-operative sloughing of the aponeurosis was followed by some bulging in the scar. The function of the bowels is normal.

The type of anastomosis after intestinal excision, presents a most interesting question and a fruitful theme for discussion. In the small intestine, end-to-end anastomosis by suture, the abdomen being closed without drainage, gives excellent results. In the large intestine, a similar procedure may be followed in the sigmoid, of which the mesentery insures proper peritoneal adaptation and protection. Furthermore in this location, a flexible rubber tube inserted into the rectum by an assistant and directed by the operator's hand through the site of anastomosis into the bowel above it, serves to conduct gas and the colon contents through the sutured segment, thereby averting the danger of possible local distention and leakage. In other parts of the large intestine where proper peritoneal covering cannot be secured, the writer prefers a side-to-side anastomosis after closure of the divided intestinal lumina. This seems to afford the greatest protection against subsequent leakage with the formation of a fistula, of which the successful closure is frequently extremely difficult. The writer has had little or no experience with end-to-side anastomosis. Theoretically, after excision of the ileocaecal junction, this method of anastomosis is supposed to restore more satisfactorily than a side-to-side anastomosis the normal condition of this part of the intestine. In informal discussion, however, with those experienced in this method of anastomosis, the writer has gained the impression that both leakage and post-operative obstruction from undue angulation or adhesions are more common than after other methods of anastomosis. Perhaps the standardization of the most desirable method of anastomosis is impossible. The per-

sonal equation may prove, after all, the determining factor, the choice of method depending upon the individual skill and preference of each surgeon.

The writer advocates drainage with a small flexible rubber tube, inclosing a wick of gauze in all cases of anastomosis involving the large intestine. Frequently the wound remains free from infection and the drain is permanently withdrawn at the end of 24 to 72 hours. Occasionally infection appears in the abdominal incision while the intestinal repair is prompt and satisfactory. In a few instances, a small fecal fistula forms, a possibility that fully justifies the use of precautionary drainage. It is scarcely necessary to add that all contact of the drain with the site of anastomosis should be carefully avoided.

While it is both impossible and undesirable to urge any special method of treatment from the experience of a single case, the result, in the present instance at least, has proved sufficiently encouraging to justify an attempt to close an artificial anus even though it be of long standing and complicated by conditions indicative of impaired reparative power.

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THE EFFECT OF PRESSURE ON ARTICULAR SURFACES IN PYOGENIC AND TUBERCULOUS ARTHRITIDES AND ITS BEARING ON TREATMENT*

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IT WAS recognized that pressure played a rôle in the destruction of articular surfaces in arthritis long before the bacterial nature of infection was known. Since the time that pyogenic and tuberculous arthritides were differentiated bacteriologically, the differences in the effects of contact and pressure on the articular surfaces in the two conditions have not been fully elaborated. In fact, it is too generally considered that they are much the same in the two conditions, that the effects are destructive, and that in both the articular surfaces are destroyed first and most extensively at the points of contact and pressure of opposing articular surfaces. Examination of a series of specimens showing each disease in its various stages demonstrates that this is not the case. The changes as influenced by contact and pressure are more accurately described for pyogenic than for tuberculous arthritis. Koenig's¹ work on tuberculous arthritis is the most extensive and exact, but inaccuracies may be found in it pertaining to the persistence of cartilage longer at certain points than at others and to bony invasion and necrosis. Also, knowledge as to proteolytic activities in pyogenic and tuberculous infections has not been utilized in explanation of the changes seen in articular cartilages in pyogenic and tuberculous joints.

In studying the effects of contact and pressure, a distinction should be made between those produced on the articular cartilage and those produced on the underlying bone. In acute pyogenic arthritis it is found that when there is an effect from contact and pressure, it is to help to destroy articular cartilage in the regions of contact of opposing articular surfaces. On the other hand, in tuberculous arthritis the effect, except in the later stages, is protective, and articular cartilage is usually preserved longest at the points of contact and pressure, while the first evidences of destruction are found over the free surfaces. The differences are present because the agents which attack and destroy articular cartilage are very different in the two processes. These observations have been made mainly on adults and on the knee-joint, where, because of large areas of both free and opposed articular surfaces, conditions are favorable for contrasting the effects of pressure and lack of pressure. They hold in varying degrees for other joints and for children. In both

* Read before the American Surgical Association, April 18, 1924.

pyogenic and tuberculous infections the articular cartilage is involved secondarily, the primary infection being either in the synovia or in the bone.

Pyogenic Arthritis. Effects of Pressure on Cartilage.—In pyogenic arthritis the articular cartilage may not become involved if the infection is mild, but if the infection is severe, cartilage will be killed, and it is generally killed first and most extensively at the points of contact and pressure of opposing articular surfaces. This is undoubtedly related to the unfavorable con-

ditions for nutrition produced by pressure. The amount of necrosis on surfaces that are not pressed upon varies. In some cases it is slight, while in others the entire cartilage may be killed. Whatever happens on one side of the joint

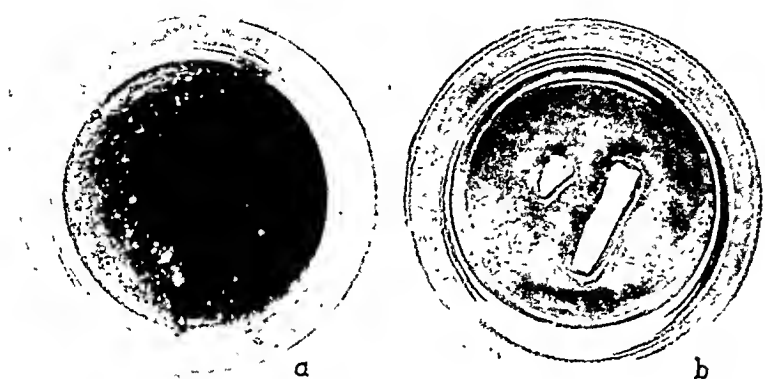


FIG. 1.—Equal amounts of articular cartilage in staphylococcus pus (a) and in tuberculous pus (b) after incubation at 55 degrees C. for ten hours; cartilage digested in (a) and undigested in (b).

usually happens on the other. If cartilage is killed in the apposed regions on one side, it is usually killed to the same extent on the other side. Dead cartilage in pyogenic arthritis is usually destroyed in a comparatively short time. It is broken down partly by the absorptive action of granulation tissue, partly by erosion of opposing articular surfaces, and partly by the digestive action of proteolytic ferments in the exudate of the joint. These ferments are derived very largely from the polymorphonuclear leucocytes, to a slight extent from broken down bacteria. Where cartilage is killed in its entire thickness, granulations from beneath its attached surface and rapidly detach it by absorption of both cartilage and bony cortex at their junction. Where only a superficial layer of cartilage has been killed in unopposed regions, it is removed mainly by digestion, but granulations may also grow from the margins over the unopposed surfaces and absorb the dead layer.

A series of experiments has been performed to test the rapidity with which articular cartilage is digested by a pyogenic exudate *in vitro*. When pieces of articular cartilage are immersed in pus produced by any of the pyogenic microorganisms and the mixture incubated at a temperature of 55 degrees C., so that proteolytic action is augmented, the cartilage is digested in from three to twenty-four hours, depending on the concentration of the pus. Figure 1 shows two watch glasses, each of which at the beginning of the experiment contained two pieces of fresh articular cartilage and underlying bony cortex of the size shown in (b). Staphylococcus pus was added to (a) and pus from a tuberculous cold abscess to (b). After incubation for ten hours, the articular cartilage in (a) was completely digested and particles of bone sand were the only solid materials remaining. The pus was more liquid than at the beginning of the experiment, because of the breaking down of its proteids and of the leucocytes themselves. At a temperature of 55 degrees C., bacterial action is suspended, so that the digestion was produced by existing ferments in the pus. That the ferments are derived very largely or wholly from the polymorpho-

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nuclear leucocytes in the exudate is shown by the fact that relatively little or sometimes no cartilage is digested, when it is incubated in a suspension of pyogenic bacteria. Experiments have demonstrated that a variable amount of proteolytic ferment is formed by different organisms, as shown by their ability to break down tissues and to liquefy such media as gelatine and blood serum. According to Bittrolff,² it is small in amount with most pathogenic forms. Heavy suspensions in normal salt solution of some strains of staphylococcus aureus were found not to digest articular cartilage, while others digested it to a slight degree. In the experiment shown in Fig. 2, equal sized pieces of articular cartilage were placed in the tubes. Tube (1) contained normal salt solution, tube (2) a suspension of staphylococci in a concentration of 15 millions per cubic millimeter, and tube (3) a suspension of 40 millions per cubic millimeter. They were incubated at 55 degrees C. for six days and there was no reduction in size of the pieces of cartilage. Microscopic examination of sections showed cartilage well preserved in the piece incubated in salt solution and only very slight breaking down of cells and vacuolation of intercellular substance in the pieces incubated in the staphylococcus suspensions. The experiments of Bittrolff,² Cacace³ and others have shown that proteins may be split by the action of bacterial ferments into albumoses, peptones and amino-acids.

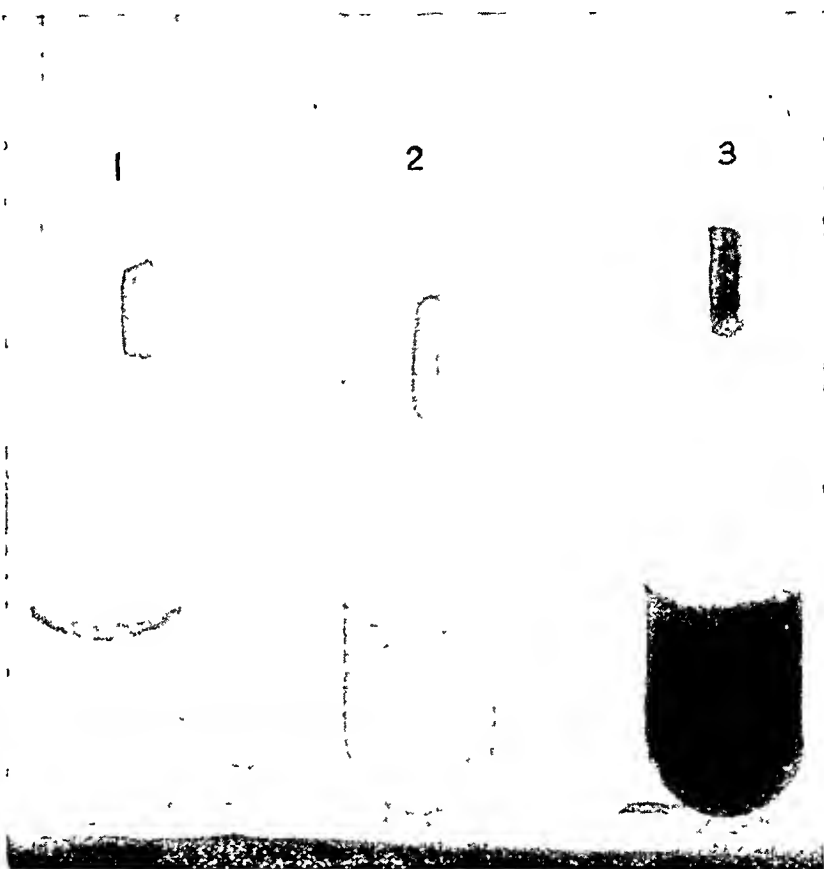


FIG. 2.—Equal sized pieces of articular cartilage incubated at 55 degrees C. for six days in normal salt solution (1) and staphylococcus suspensions (2) and (3). No change in (1) and only slight microscopic changes in (2) and (3), showing little digestion by the bacteria.

Effects of Pressure on the Bone.—

In pyogenic arthritis the changes in the bone bordering on articular surfaces vary according to the point of primary infection. In primary arthritis with secondary involvement of cartilage, the articular cortex of bone is nearly always destroyed in those regions where the entire thickness of articular cartilage is broken down. Consequently it is destroyed oftenest and most extensively at the points of pressure. An inflammatory reaction is seen in the adjacent layer of spongy bone of these regions, but deep invasion producing osteomyelitis and sequestration, even at the points of pressure, is rare. In infected penetrating wounds of joints with associated joint fracture and osteomyelitis, death of detached bony fragments is common. When the primary infection is an osteomyelitis which spreads into the epiphysis and the joint, necrosis and sequestration of bone bordering on the articular surface is not uncommon, and even here, as in the head of the femur, it may be greatest in the weight-bearing region. When bone and overlying articular

cartilage are both killed, the cartilage rapidly disappears by the digestive action of ferments, but the dead bone with its layer of articular cortex may persist and be separated as a sequestrum.

Figure 3 shows a photograph of the articular surfaces of the bones of the knee and ankle, which were involved in arthritis by direct extension from staphylococcus osteomyelitis of the entire shaft of the tibia in a twelve year-old boy. The infection in the knee was purulent and was drained on the fifty-fourth day, when the patient was admitted to the Presbyterian Hospital. That in the ankle was less severe and had subsided without drainage when the limb was amputated above the knee on the seventy-fifth day of the illness.

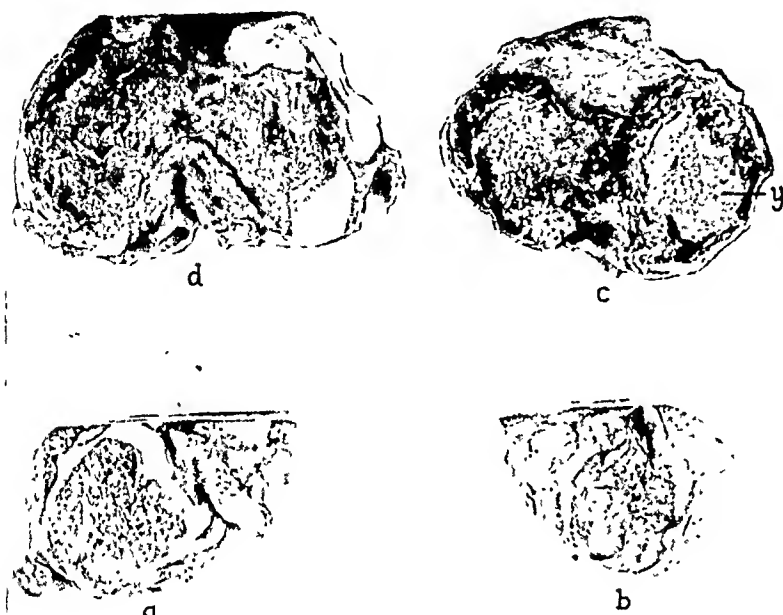


FIG. 3.—Joint surfaces in pyogenic infections of knee and ankle. Cartilage destroyed at pressure points and largely preserved where not compressed on astragalus (a), lower end of tibia (b) and femur (d). Cartilage all destroyed on upper end of tibia (c). Cortical sequestrum (y).

tuberosities (c). The cartilage had been destroyed by digestion, but portions of articular cortex were present as disc-like sequestra. The one on the internal tuberosity is shown *in situ* at (y) in Fig. 3. The femur (d) showed complete disappearance of articular cartilage and of underlying cortex on the condyles at the points of contact and pressure with the tibia and partial destruction of cartilage and cortex at the point of contact with the patella, which latter structure had also lost its cartilage, excepting remnants about the periphery. The cartilage was largely preserved on the remaining free surfaces anteriorly between the points of contact with patella and tuberosities, and posteriorly on the condyles, but its surface was mostly uneven from superficial destruction.

This case illustrates well the disappearance of cartilage and cortex where pressed upon by opposing articular surface, the survival of cartilage in the regions of the joint that are free from pressure, and the preservation of bony cortex and disappearance of cartilaginous covering on an articular sequestrum. A comparatively mild acute arthritis may involve articular cartilage at the points of greatest pressure, which will lead to bony ankylosis, unless measures are introduced to combat it.

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Figure 4 shows a photograph of the articular surfaces of the right knee five months after the onset of a hæmatogenous arthritis secondary to erysipelas of the left thigh. There was an effusion at the onset and aspiration yielded a turbid serous fluid, from which a hæmolytic streptococcus was grown. The infection subsided spontaneously after six or seven weeks, leaving the joint with only a small range of motion. Extension was not applied to the limb, nor was the joint mobilized. The limb was amputated because of recurrence of an old staphylococcus osteomyelitis of the upper end of the femur with coxitis. Dissection showed destruction of articular cartilage and cortex at the points of contact of external condyle (a) and external tuberosity (b), which is the region of greatest pressure in the knee-joint, and a bony bridge was in process of formation here. The articular cartilage was preserved elsewhere on the tibia and femur and on the patella, but there was extensive fibrous ankylosis present in these regions. The extreme degree of destruction of cartilage and fibrous ankylosis resulting from the comparatively mild arthritis was no doubt related to the fact that the knee was neither mobilized nor extended during any part of the course of the infection.

In moderately severe pyogenic arthritis, it may rarely happen that articular cartilage and underlying cortex are destroyed at the points of pressure on one side of the joint and persist on the other. The presence of cartilage on one side lessens the liability to the development of ankylosis, and there may be healing with preservation of considerable motion. The area of destroyed articular surface is repaired by the outgrowth of granulation tissue from the underlying bone, and it may overgrow the surrounding cartilage, producing a ridge about the articular surface. Figure 5 shows the articular surfaces of a man's knee, resected one year after spontaneous healing of a mild seropurulent arthritis, resulting from extension of a staphylococcus osteomyelitis of the tibia. The articular surfaces had been destroyed at the points of contact on the condyles of the femur, but not on the tibia, where they were somewhat protected by the marginal support of the semilunar cartilages. The



FIG. 4.—Ankylosis five months after mild undrained arthritis of knee. Cartilage destroyed only at points of pressure of external condyle (a) on external tuberosity (b). Fibrous ankylosis elsewhere.

damaged areas on the condyles had been repaired by a layer of fibrocartilage, the margins of which were raised and in places overhanging. A sagittal section through the lateral condyle showed that articular cartilage and cortex had been destroyed at the point of greatest pressure and that reparative tissue had grown over from the underlying bone, filling the defect and overlying the margins of surrounding cartilage. (Fig. 6) The superficial portion of this tissue was fibrocartilage, while the deeper portions had ossified.



FIG 5.—Healed undrained pyogenic arthritis of knee. Roughened healed areas where cartilage is destroyed at points of pressure on condyles of femur (a); cartilage on tibia (b) little changed

The shadow cast in the röntgenogram by the new bone overlying the remaining articular cartilage gives the appearance of a bony disc interposed in the cartilage space of the joint between condyle and tuberosity (Fig. 7). If cartilage and cortex break down on both sides of the joint, it is extremely difficult to avoid the occurrence of bony ankylosis

Tuberculous Arthritis. Effects of Pressure on Cartilage.—In tuberculous arthritis the point of primary infection is either in the bone or in the synovial lining, and the articular cartilage becomes involved secondarily. The inflammatory reaction is not sufficiently severe to kill articular cartilage *en masse* in

the early stages of the disease, as is so often the case in pyogenic arthritis. Tuberculous synovitis usually runs for months and is well established before there is any sign of destruction of articular surfaces. The articular cartilage is then first killed and absorbed by the direct attack of tuberculous granulations, which grow onto it from the surrounding synovia. They attack it first along its free surfaces and about its margins, where they can readily get at it. The cartilage is protected from surface attack of tuberculous granulations in the regions of contact and pressure of opposing surfaces in the joint, and the

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destruction may be very marked along the free surfaces and about the margins before there is any change in the cartilage of the contacted regions.

This is illustrated by Fig. 8, which shows the articular surfaces of the resected femur and tibia in tuberculosis of the knee of about fifteen months' standing in an eighteen year old boy. There was marked tuberculous synovitis and granulations had attacked the cartilage of the tibia about its margins, but the central portions of cartilage on either tuberosity were free from attack, as were the surfaces of the condyles of the femur with which they come in contact. The surfaces of contact of patella and femur were also free. Granulations covered the free cartilaginous surface of the femur between its points of contact with pa-

tella and tibia and on the posterior surface of the condyles, and had absorbed most of the thickness of cartilage. The layer of granulations is seen intact between patellar surface and internal condyle, but it has been removed, leaving a grooved and roughened surface, between the patellar and external condylar surfaces.

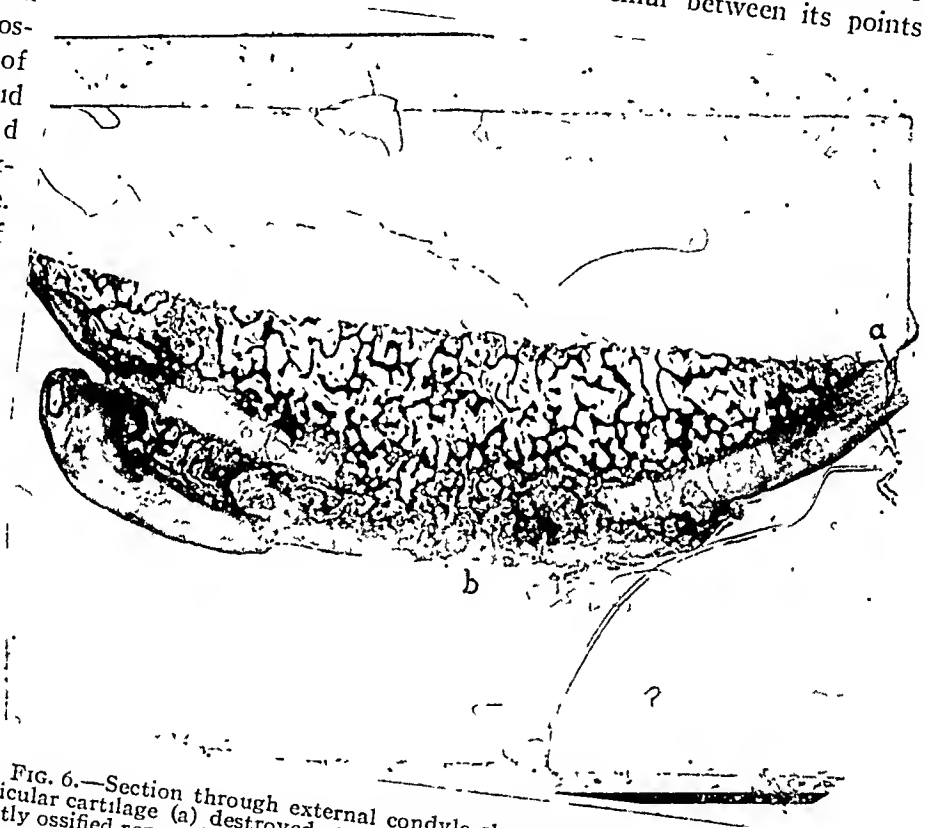


FIG. 6.—Section through external condyle shown in Fig. 5, showing layer of articular cartilage (a) destroyed at point of greatest pressure and overgrown by partly ossified reparative tissue (b) growing out from the bone.

Destruction of cartilage in the regions of contact and pressure is usually brought about first by undermining subchondral granulations, which may be tuberculous in nature about the periphery of the cartilage, but which are non-tuberculous beneath the more centrally located portions of cartilage. There they consist of capillaries, fibroblasts and round cells, and in the capillary loops that invade and absorb the cartilage polymorphonuclear leucocytes may be seen. They gradually detach the cartilage by absorbing articular bony cortex and the deeper portions of cartilage. As in pyogenic arthritis, whatever happens on one side of the joint usually happens on the other. If cartilage is preserved or eroded or undermined on one side the same condition obtains at points directly opposed.

These changes are well illustrated in Fig. 9. It shows the articular surfaces of the femur and tibia of a man whose knee was resected because of tuberculous arthritis of two and one-half years' standing. Cartilage is attached and preserved on the central portions of the surfaces of contact of femur with patella and of lateral condyle with lateral tuberosity, which is the point of greatest pressure in the joint. This is the region in the knee-joint where cartilage usually persists longest. It is detached and thinned by under-

mining granulations on the mesial condyle and tuberosity. It has been destroyed everywhere else in the joint except in these regions of contact, and they show marginal absorption. Figure 10 is a side view of the same specimens, with a sagittal section through the lateral condyle. It shows the preservation of cartilage and of articular cortex of bone at the points of contact of patella and of tibia with femur and the loss of cartilage and of articular cortex in the unopposed regions. The preservation of cartilage space and of



FIG. 7.—Röntgenogram of knee shown in Fig 5. The ossified reparative tissue overgrowing the articular cartilage about margins of the regions of destruction cast disc-like shadows in cartilage spaces between condyles and tuberosities.

whose articular surfaces have like contour and in which cartilage fits snugly against cartilage throughout, leaving little or no unopposed surface, the loosening and destruction of articular cartilage is carried on mainly by the action of undermining granulations. This is true of the hip and ankle-joints, where, on opening the joint at the right stage, the cartilages may be found completely detached and considerably thinned from beneath, while there is little or no evidence of destruction along their free surfaces. After the disease is well advanced and destruction is extensive in the unopposed regions of the joint, the remaining cartilage in the opposed regions

articular cortex in the opposed regions is demonstrable in the röntgenogram taken before operation and shown in Fig. 11.

The first röntgenographic evidences of destruction of articular cortex in tuberculosis of the knee are usually seen along the free surfaces and about the margins of the articular surfaces. Preservation of both the normal width of cartilage space and shadow of cortex in the regions of contact and pressure is in favor of tuberculous arthritis, while loss in those regions with preservation elsewhere in the joint is in favor of pyogenic arthritis.

In those joints

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may become necrotic. Cartilage is also killed *en masse* when the undermining granulations destroy its bony connections. In fact, the explanation of the development of the non-tuberculous subchondral granulations may be the necrosis of the cartilage without the entrance of tubercle bacilli into the subchondral regions. The granulations then form as a foreign body reaction to absorb and sequester the dead cartilage.

The experimental work of Nussbaum⁴ supports the theory that articular cartilage, except the deepest layer, receives its nutrition from the synovial fluid. If the joint fluid continues to be the source of nutrition for the cartilage in tuberculous arthritis, it is understandable how, after the disease is well advanced, the altered exudate no longer furnishes adequate foodstuffs for cartilage and it dies *en masse* from lack of nourishment, as well as from the effect of tubercle toxins.

Dead cartilage, whether attached or detached, may persist in the joint for incredibly long periods, because of the absence of active proteolytic ferments in the tuberculous exudate. Pressure and motion erode and destroy dead cartilage. But when these are absent or slight, detached discs may persist for many months and dead cartilage may stand for years on articular sequestra, since granulations cannot get at its base to absorb it and there are no proteolytic ferments in the exudate to digest it. Edward Mueller,⁵ Jochmann,⁶ Opie and Barker,⁷ and others have shown that exudates in tuberculous processes, including cold abscesses, contain practically no active proteolytic ferments, and we know that tuberculous granulation tissue is killed by coagulation necrosis, coagulins being formed by the tubercle bacilli (Ruppel,⁸ Schmoll⁹) which precipitate the soluble colloids of the cells. The caseous areas persist for extremely long periods, because of the absence of active digestive ferments.

No published studies were found on the effect of tuberculous exudates on dead articular cartilage in relation to the persistence of cartilage in tuberculous joints. The digestive action of tuberculous exudates on cartilage was tested *in vitro*. Cold abscesses were aspirated and cartilage was incubated

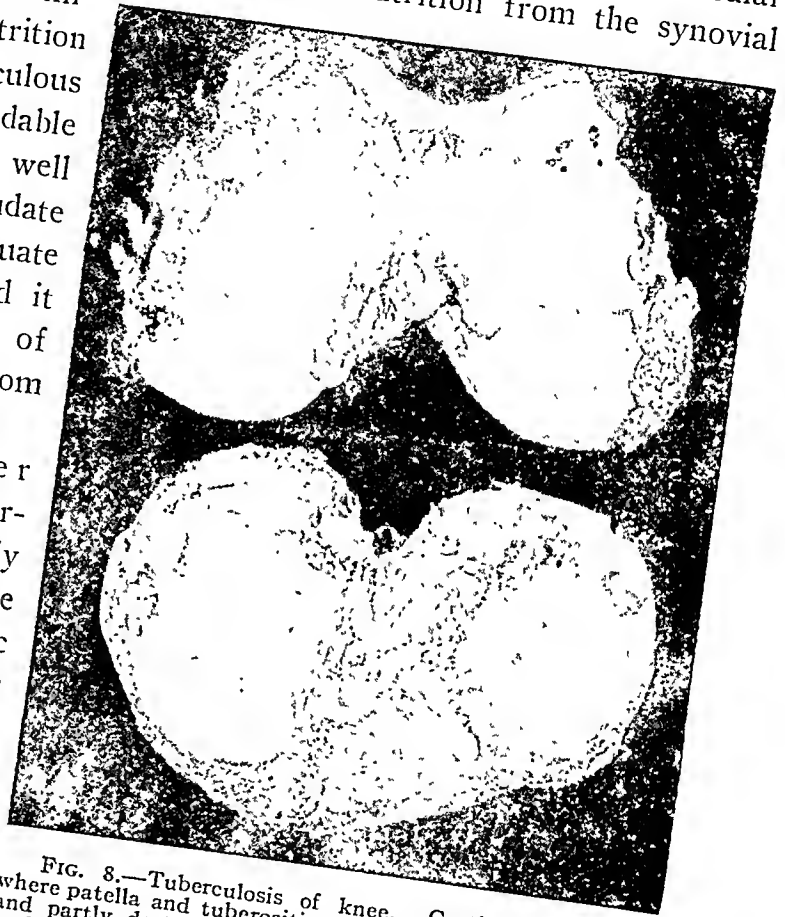


FIG. 8.—Tuberculosis of knee. Cartilage preserved where patella and tuberosities come in contact with femur and partly destroyed along unopposed surfaces of tibia

at a temperature of 55 degrees C. in the fluid obtained. The tuberculous fluid coagulated in a short time, due to its richness in albuminous substances, and both articular cartilage and coagulum persisted after several days of incubation without any signs of digestion. This shows the absence of proteolytic ferment in the exudate. The tubercle bacillus is found to contain no proteolytic ferments and its toxins destroy the autolytic enzymes of the dead tissues. Consequently there is no autolysis of the dead cartilage. The leucocyte present in the tuberculous granulations and exudate is mainly the large mononuclear cell. It contains some

proteolytic ferment, which is active in acid media, but not in tuberculous exudates, which are always alkaline in reaction (Opie and Barker⁷).

Figure 1 (b) shows cartilage unchanged and tuberculous fluid coagulated after ten hours of incubation. Figure 12 shows test tubes, 1, 2, 3 and 4, in which were placed equal sized pieces of cartilage. To them were added, respectively, salt solution, tuberculous pus, staphylococci suspended in salt solution and staphylococcus pus. They were incubated for 40 hours at 55 degrees C. The cartilage remained unchanged in the salt solution and in tuberculous exudate, and the latter coagulated; cartilage in the bacterial suspension was slightly reduced in size, while that in the staphylococcus pus was completely digested. The



FIG. 9.—Tuberculous knee of two and one-half years' duration. Cartilage largely preserved at points of contact of patella and tibia with femur and destroyed elsewhere in joint. Contacting cartilage undermined on mesial condyle (a) and mesial tuberosity (b).

pus in tube 4 was much more liquid than it was at the beginning of the experiment.

The Effect of Pressure on the Bone in Tuberculous Arthritis.—Secondary invasion of the bone in tuberculous arthritis does not usually occur as long as the articular cartilage remains little disturbed. The non-tuberculous granulations which undermine the cartilage as the disease advances are superficial and rarely invade the bone to any appreciable extent. The tuberculous granulations which undermine the margins of the cartilage and attack the bone in regions where cartilage has been completely destroyed may invade the bone to some extent, absorbing it, with resultant pits and grooves in the bony surface. Secondary invasion of bone resulting in necrosis and sequestra is of rare occurrence in the regions of the joint that are not subjected to

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pressure. While cartilage is usually protected and preserved longest at the points of pressure, the bone in these regions, after joint cartilage is largely or entirely destroyed, does not fare likewise. On the contrary, it is more subject to involvement than that in any other part of the joint. When cartilage has disappeared, the pressure and friction of bony surfaces may produce extensive bony erosion, as of femoral head and acetabulum at the hip, with pathological dislocation. Occasionally in weight-bearing joints, particularly the knee, there may be sclerosis of the bone to some depth and polishing of the bare bony articular surfaces at the points of weight-bearing. At an advanced stage there is

not infrequently extensive secondary invasion of bone in the zones of pressure, either before or after their coverings of cartilage have been completely destroyed. Undoubtedly the damaging influence of pressure is instrumental in producing this invasion, and if the bone is

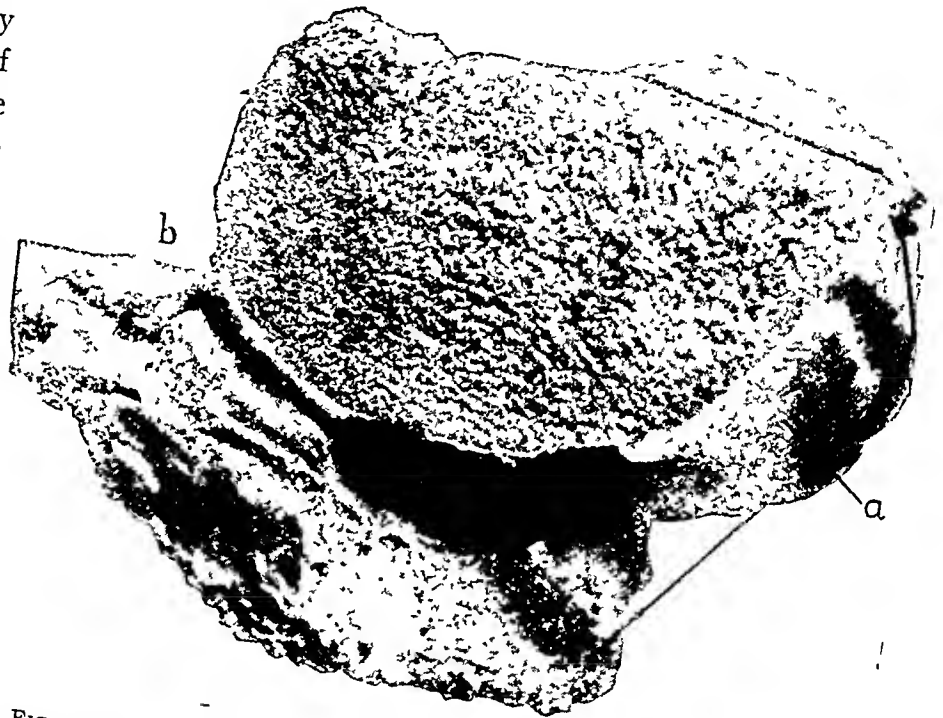


FIG. 10.—Lateral view of joint in Fig. 9 with sagittal section through lateral condyle, showing cartilage preserved in regions where femur came in contact with patella (a) and tibia (b). Cartilage destroyed elsewhere.

invaded on one side of the joint, it is apt to be invaded on the other side. This results in necrosis of bone, and the areas are so large that the dead bone is usually not absorbed, but is gradually sequestered. When the condition is bilateral, it produces "kissing sequestra." If cartilage is still present on the articular surface at the time of invasion, it will die and may subsequently be removed by erosion, or it may stand for a very long time, as granulations cannot readily get at it and the exudate does not break it down by proteolysis. The articular cortex is always preserved on the sequestrum, if cartilage is still present at the time of bony invasion. The sequestra usually show some evidence of bone atrophy, which had occurred from disuse before invasion and death of the bone. After death their density remains stationary, while that of the surrounding living bone is gradually reduced as the result of continued atrophy and absorption. In the röntgenogram such sequestra are recognizable by their density, which is greater than that of the surrounding living bone, and by

the presence of a shadow of articular cortex and sometimes of a zone of demarcation. If articular cartilage and cortex have been destroyed before bony invasion, there may be seen in the röntgenogram no sharp outline of the articular surface of the sequester. If bony sclerosis and polishing of the surface develop before bony invasion and death, the shadow of cortex and of underlying bone in the sequester may be very heavy. In fact, sclerosis may very rarely result in density which is greater than that of normal bone of the region. Occasionally there may be calcification of the necrotic



FIG 11.—Side view of röntgenogram of joint in Fig 9, showing cartilage space and articular cortex preserved in regions of contact of external condyle and tuberosity and of patella and femur, and articular cortex absent elsewhere.

posed to it in the ilium, which cast heavier shadows than the surrounding living bone and are separated from it by zones of demarcation. A definite, sharp shadow is cast by articular cortex on each dense area, while the shadows of articular cortex in the rest of the joint are absent. At operation by Doctor Ryerson extensive tuberculous coxitis was found. In the regions casting denser shadows there were two kissing sequestra. On each the articular cortex was preserved, and there was a thin layer of cartilage about the periphery of the much more extensive articular surface of the sequester from the head (Fig. 14). The findings indicate that articular cartilage was present on both areas when they were invaded and killed, and that the dead cartilage in the regions of contact of the two surfaces was destroyed by erosion, while that on the unopposed margins of the larger surface of the head was only partly destroyed. On microscopic examination evidence of slight atrophy of disuse was found in both sequestra, which indicates that an interval of time separated

tissue of the cancellous spaces of the dead bone, which may cause the sequester to cast a heavier shadow than normal bone of the region.

Figure 13 is of a röntgenogram taken three years after the onset of tuberculous coxitis in a man, which had produced marked symptoms and had been treated by immobilization during the previous six months. At the top of the joint, which is its point of greatest pressure, there is an area in the head and one op-

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the bony invasion from the onset of the disease. The presence of atrophy within the sequestra, their equal density, and their situation at the point of greatest pressure in the joint are conclusive evidence that they arose from simultaneous secondary invasion.

The presence of opposing sequestra in the knee-joint has been mentioned by Koenig¹ and Krause,¹⁰ but an incorrect explanation of their development was given. Koenig assumed that one sequestrum represented the area of primary infection and that the other arose by secondary invasion across the joint after tuberculous arthritis had been established. No mention is made

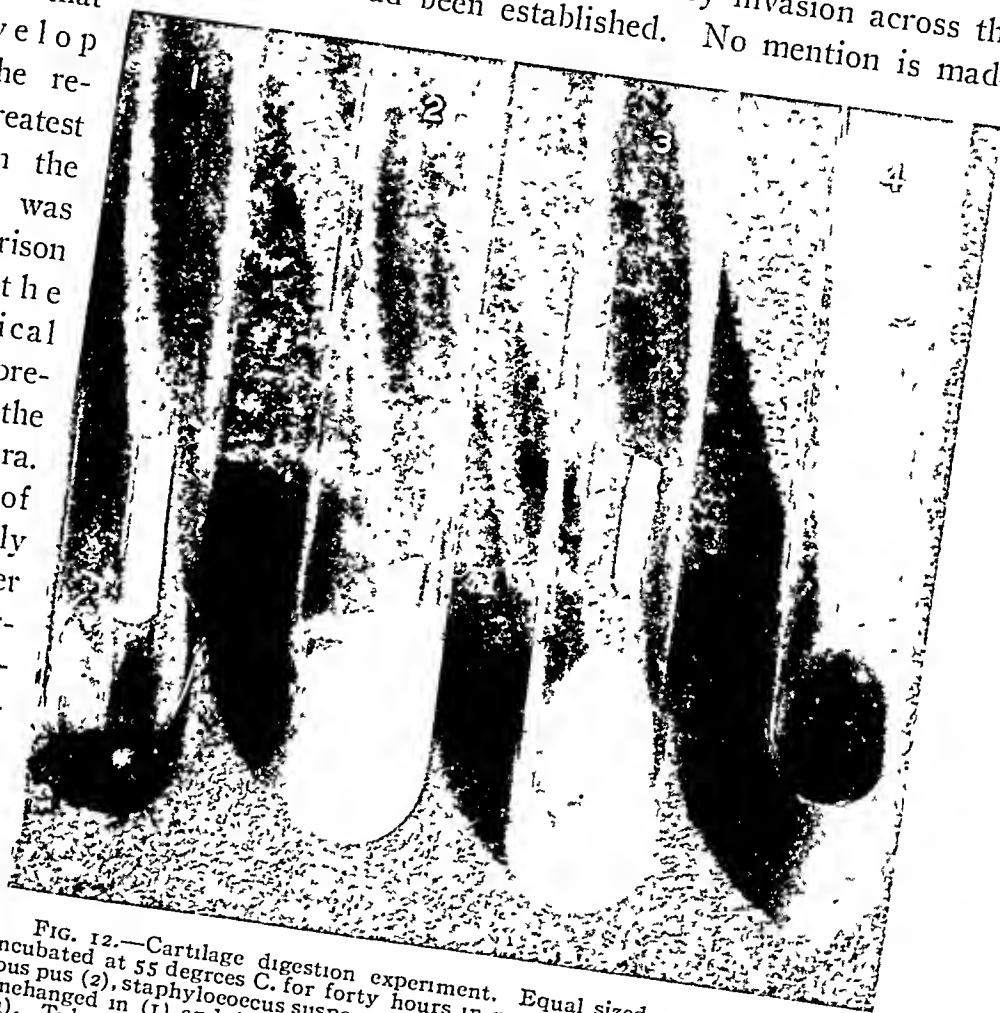


FIG. 12.—Cartilage digestion experiment. Equal sized pieces of cartilage incubated at 55 degrees C. for forty hours in normal salt solution (1), tuberculous pus (2), staphylococcus suspension (3) and staphylococcus pus (4). Cartilage unchanged in (1) and (2), slightly changed in (3) and completely destroyed in (4). Tuberculous pus (2) was coagulated and staphylococcus pus (4) was liquefied.

of the fact that they develop only in the regions of greatest pressure in the joint, nor was any comparison made of the pathological changes presented by the two sequestra. In a study of a comparatively limited number of joints operated on for advanced tuberculous disease, I have met with eight instances of kissing sequestra or opposed areas of necrosis in which sequestration was not yet complete. Seven were in the knee and one, the case above reported, in the hip. Detailed röntgenological and pathological examinations show that in every instance the bony invasion occurred simultaneously and secondarily on the two sides of the joint. That the lesions developed simultaneously is shown by the fact that the pathological changes are exactly the same on the two sides. They each present the same degrees of density and of destruction. If articular cortex is present on one, it is present on the other also. If dead articular cartilage is found on one, it is found on the other, unless the articular surfaces are of unequal size, in which case cartilage may be absent from erosion where the surfaces of the sequestra come together, but present on the unopposed portion of the larger surface.

That both sequestra arose secondarily is shown by a number of facts. Since the pathological evidence indicates that the two lesions arose simultaneously, it is evident that they are either both primary or both secondary osseous involvements. It is inconceivable that bacteria from the blood stream would so often lodge at the same time in the bone underlying directly opposed surfaces of the joint, and always in the regions of greatest pressure. Microscopic examination of the sequestra showed evidences of atrophy of the bone before its death. In some cases the atrophy was slight, while in others it was very marked and equal to that in the surrounding living bone. The necrotic bony areas may be found attached to the surrounding living bone, with few signs of absorption and sequestration about their margins. This is evidence of recent invasion, and when the dead bone is also atrophic, the secondary nature of the lesions is definitely established.

The shape of an area of necrosis is variable. It may be that of an oval or often that of a low cone with its base bordering on the joint. Since Koenig's publications it has been the custom to regard all cone-shaped areas of necrotic bone with their bases on the articular surface as the result of embolism, clumps of tubercle bacilli, either alone or in tuberculous debris, lodging in end arteries of the epiphysis and infecting the area supplied by the obstructed artery. The recent work of Nussbaum,¹¹ showing that the arteries of the epiphysis, unlike those of the metaphysis, are not end arteries, has cast doubt on the correctness of this theory. It is readily apparent that areas of necrosis from secondary invasion of the bone have been confused with those from primary hematogenous invasion. Some authors, as Nichols,¹² have claimed that practically all tuberculosis of the joints arises by extension from a primary focus in the adjacent bone, and they cite the presence of sequestra and necrotic bony areas as the most important evidence in favor of the contention. The mere presence, along the articular surface, of a sequestrum or of a cavity remaining after necrotic bone has been absorbed, is not proof that the primary infection was in the bone. Careful examination from the standpoints of location, density, bilateral involvement and amount of sequestration will show that many of these bony lesions are the result of secondary invasion.

The following is another case in point: Male, age sixty-eight, had mild tuberculous arthritis of the knee for fourteen years, during which time he received no treatment and worked on the limb continuously. The symptoms then became markedly aggravated, and Fig. 15 shows the appearance of the joint in the röntgenogram eight months later. The joint was then resected, and two opposed areas of bony necrosis were found in the region of contact of mesial condyle and tuberosity, as shown in Fig. 16. That the bony invasions were approximately simultaneous and of recent date is evident from the fact that the density of the bone in the two necrotic areas and in the surrounding living bone is the same and is considerably less than normal. Gross and microscopic examinations of the regions involved showed only partial sequestration of the dead bone and an equal degree of atrophy in the dead and living bone. The röntgenographic features of tuberculous and pyogenic arthritis have been described elsewhere in greater detail. (American Journal of Röntgenology and Radium Therapy, July, 1924.)

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In case of cold abscess and fistula formation in tuberculous joints, there may be invasion and infection by pyogenic organisms, greatly complicating the pathological picture. After pyogenic arthritis has been engrafted on tuberculous arthritis, the destructive effects of the former may be seen in the regions of contact and pressure and all articular cartilage killed *en masse* by the tuberculous process may be rapidly destroyed. However, tuberculous joints with fistulæ of even long standing very frequently show no evidence of secondary pyogenic infection.

Bearing of Pressure on Treatment.—It is readily seen from the pathological changes in articular surfaces that contact and pressure have a bearing on treatment, and that it is different in pyogenic from what it is in tuberculous arthritis.

In pyogenic arthritis the aim of treatment should be to limit and to overcome the infection and to preserve motion. The agencies which assist in the realization of one of these aims may be helpful, indifferent or harmful in the realization of the other. Pressure exerts an unfavorable influence on the spread of the infection, inasmuch as it disposes to invasion and destruction of articular surfaces at points of contact; and destruction of articular surfaces disposes to the development of ankylosis. Pressure is increased by weight-bearing and by marked effusion in the joint, distending the capsule and forcing articular surfaces together. Pressure may be relieved to some extent by drainage and by extension. Drainage acts beneficially by permitting the escape of noxious and of necrotic substances, to a slight extent by the relief of pressure. Incision should be adequate for the degree of the infection, and should be



FIG. 13.—Tuberculosis of hip, showing two kissing sequestra at point of greatest pressure in joint.

resorted to oftener than is commonly practised in the milder cases. The danger of aggravating a severe turbid serous or seropurulent arthritis by arthrotomy plus careful post-operative dressings, except in the presence of severer neighboring infection, as osteomyelitis, has been exaggerated. Limitation of motion following loss of articular surfaces at the points of pressure only may be lessened or obviated in this way. The insertion of a drain is unnecessary where the overlying soft parts are thin, but where thick, as at the hip or shoulder, a tube should be inserted and its end sutured to the synovia. Excepting in very

mild cases, pyogenic arthritis should be treated during the active stage of the disease by extension, unless it is impractical because of the location of the joint or the presence of neighboring disease. In view of the pathological changes that result from pressure, it would seem good practice to diminish or if possible entirely relieve it by extension, unless there are very strong arguments to the contrary. The main argument to be advanced against extension is that it interferes with motion. Moving the joint acts beneficially by increasing drainage and by obviating continuous pressure of opposed articular surfaces in one region. Willems¹⁷ has advocated motion and when possible weight-bearing at every



FIG 14 —Photograph of kissing sequestra shown in Fig. 13.
(a) from ilium and (b) from head.

stage of arthritis, because they assist in drainage. It should be remembered that, in general, motion is harmful to infected tissues and that friction and pressure of opposing articular surfaces favor cartilage destruction. Does the advantage of drainage derived from pressure by weight-bearing outweigh the advantage of protection of articular cartilage derived from extension, and is the increased drainage produced by motion more beneficial than rest? It is a curious fact that almost no mention is made by Willems of the pathological changes that may occur in the articular surfaces and of the influences they may have on the therapeutic result, particularly as concerns mobility of the joint. It is impossible to conclude from Willems'

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writings, whether he holds that if one follows his methods there will be no pathology in the articular surfaces or that, regardless of the extent of changes from the infection, his methods will give a better functional result than any other.

It would appear that rational management of pyogenic arthritis consists in early and free drainage and, whenever possible, extension of the joint. Mobilization with the weight

lifted should be inaugurated as soon as one feels that it will be tolerated. Whether or not it should be carried out from the beginning of treatment is a question that is still open for debate. Mobilization in arthritis is often very difficult to carry out, because of the severity of the general condition, as sepsis, or of the regional condition, as osteomyelitis, of which it is a complication. In general, mobilization should be started only after the peak of the acute infection has been passed, and extension should be continued along with it until general symptoms have partially subsided and the discharge has become slight and has lost its purulent nature.

By that time the danger of augmenting by

pressure the infection of articular surfaces has passed and motion for the purpose of restoring function may be pushed to the limits of toleration. Röntgenograms of joints in continuous extension show that it is difficult to procure any appreciable amount of separation of articular surfaces unless considerable weight is applied. With light weight extension pressure between apposed joint surfaces may still be sufficient to cause greater breaking down there than elsewhere. Thus in a case of suppurative arthritis



FIG. 15.—Tuberculosis of knee of fourteen years' standing in sixty-eight year old man. Secondary kissing sequestra, seen in Fig. 16, in mesial condyle and tuberosity, not recognizable in röntgenogram because both the dead and the surrounding living bone were equally atrophic.

of the hip-joint drained two weeks from the onset (during which time there must have been considerable necrosis of joint surfaces) there was later röntgenologic evidence of progressive destruction of the upper part of the head and of opposed acetabulum despite the fact that an eight pound weight extension was kept up during the ensuing six weeks.

In the treatment of tuberculous arthritis there is more variation of opinion, both as to aims that should be sought and as to the methods of achieving them, than is the case in the treatment of pyogenic arthritis. By operative treatment one generally aims to obtain healing with bony ankylosis, which, once established, is the surest safeguard against recurrence. By non-operative measures

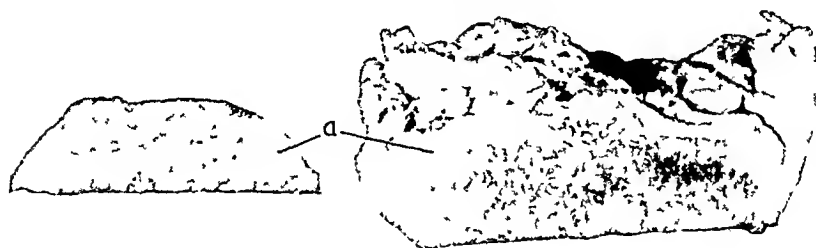


FIG. 16 —Resected specimens from joint in Fig. 15. Coronal section through tibia and sagittal section through mesial condyle, showing kissing sequestra (a) where it and mesial tuberosity were in contact. The necrotic areas of bone atrophic and partially sequestered, showing recent development.

the majority of surgeons try to obtain healing with the greatest possible limitation of motion, preferably with ankylosis, while a few strive for heal-

ing in some cases with preservation of motion. Pressure plays a rôle in the non-operative treatment, in that it modifies the time and manner of cartilage destruction, and after cartilage is destroyed it disposes to erosion or extensive invasion and necrosis of bone to which it is applied. By leading to extensive necrosis of bone followed by sequestration, it may create the necessity for operative interference in the course of conservative treatment.

Immobilization without extension of the joint in the earlier stages of tuberculous arthritis should theoretically be the best method for preservation of cartilage at the points of contact and pressure. Extension would tend to pull the surfaces apart and in that particular would enable the granulation tissue to get at and destroy more of the articular cartilage. As previously stated separation by extension is difficult of accomplishment. At the same time extension brings into play the favorable factor of fixation, which tends to lessen the extent of the tuberculous changes. This makes it difficult to estimate the separate effects of extension and of fixation on the articular cartilage. If preservation of articular cartilage is what is desired, there are in the pathological findings certain grounds for believing that it is more likely to be realized from fixation alone than from fixation plus extension. Surely, those who argue that if extension is not applied, articular cartilage will soon be destroyed in the regions of contact and pressure are in error. There seem to be perhaps equally good grounds for arguing that if extension is applied, articular cartilage will be destroyed earlier than usual in those regions, because then the granulations would have a better chance to get at its surfaces. It is

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even possible that some of the beneficial effects derived from extension have come from this more rapid loss of cartilage, which puts the joint in a more favorable condition for the occurrence of ankylosis. Theoretically, it would appear that healing with motion is more apt to come from the treatment of early tuberculous arthritis by immobilization alone than by extension, because immobilization alone is more apt to preserve cartilage, and preservation of cartilage is a prerequisite for motion. Lorenz and others claimed improved results from treatment by immobilization plus weight-bearing in tuberculous arthritis of the lower extremity. If this is right, it should be worth while to investigate whether the extra pressure of weight-bearing is the beneficial factor, and, if so, whether it acts by hastening the destruction of articular cartilage or by assisting in its preservation. Once articular cartilage is destroyed in a case of tuberculous arthritis, extension would seem a rational procedure, if the disease is progressive, since it should then protect the bone from erosion or extensive invasion with sequestration at the points of pressure.

Further röntgenological and clinical observations made with the anatomical changes herein noted kept in mind, should throw additional light upon the influence which pressure has upon the therapeutic results in both pyogenic and tuberculous infections of joints. They should be made on patients treated with and without extension and with and without weight-bearing.

CONCLUSIONS

1. In pyogenic arthritis articular cartilage is killed and broken down first at the points of contact and pressure of opposing articular surfaces.
2. In tuberculous arthritis articular cartilage is not killed first, but is protected at the points of contact and pressure of opposing articular surfaces. Cartilage is extensively destroyed first along the free surfaces, where the tuberculous granulations can grow onto and remove it. It usually disappears last in the regions of contact and greatest pressure in the joint, where it is detached and killed by undermining granulations and is then partly eroded by pressure of opposing bony surfaces.
3. Proteolytic ferments derived largely from polymorphonuclear leucocytes assist greatly in the rapid removal of necrotic cartilage in pyogenic arthritis. Proteolytic ferments are absent in tuberculous arthritis, and masses of dead cartilage may persist for months or years, showing few signs of progressive destruction.
4. In pyogenic arthritis the infection rarely invades secondarily the deeper portions of the bone at the points of pressure.
5. In tuberculous arthritis invasion of the bone at the points of pressure is of common occurrence after the articular cartilage has been largely or wholly destroyed. The invasion is frequently on both sides, in which case it may lead to the formation of kissing sequestra at the points of greatest pressure in the joint.
6. Weight extension should be applied during the active period of pyogenic

arthritis to lessen the amount of invasion and destruction of articular surfaces at the points of contact and pressure.

7. On the other hand, it would appear that extension for preventing the destruction of articular cartilage in tuberculous arthritis is not indicated. But when articular cartilage has already been destroyed, extension should lessen the tendency to erosion or invasion with sequestration of bone at the points of greatest pressure in the joint.

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ENTEROSTOMY AS A THERAPEUTIC AND DIAGNOSTIC MEASURE*

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EXPERIENCE and observation have taught me that enterostomy might, with advantage be resorted to much more often than it is. The term "enterostomy" is here used to signify opening of any part of the intestinal tract regardless as to whether or when closure is to follow. Not as frequently as was the case a few years ago, but still all too frequently, the surgeon is confronted with patients dying from obstruction of the bowel consequent upon an acute abdominal infection in whom the paramount indication is relief of the abdominal distention and drainage of the intestine, and in whom care of the focus of infection for the time being is of secondary importance and because of the desperate condition of the patient would better be left to be dealt with later. The following case, reported in brief, is but one of a number occurring in my practice which illustrates the point:

Mrs. A. was seen at her home in the country at night in extremis from bowel obstruction consequent upon acute puerperal infection. Extreme abdominal distention, leaky skin, vomiting, weak and rapid pulse were the outstanding symptoms. The pelvis was doughy but there was no fluctuation. A rapid enterostomy done with the patient in her bed was followed by prompt improvement and three days later the pelvic abscess discharged per vaginum. Complete recovery with closure of the enterostomy followed.

Enterostomy in an obstructed loop of intestine prior to removing the cause of obstruction will frequently aid in determining whether or not excision is necessary, will lessen the danger of fatal toxæmia following relief of the obstruction, and make the relief of the obstruction much easier.

Given a volvulus or strangulated hernia wherein the viability of the involved bowel is questionable, opening and draining the gut helps one to determine more quickly and certainly for or against excision and removes the danger of toxæmia from the passage of the stagnant content through the remaining part of the gut.

Again in a case of obstruction without strangulation, enterostomy and drainage of the obstructed gut removes the danger of toxæmia and facilitates completion of the operation. I have a strong feeling, prompted by considerable experience, that many of the deaths following operation for bowel obstruction might be prevented by opening and draining the obstructed bowel of its contents *before the obstruction is removed*.

The danger from soiling the wound may be avoided in large measure and is not as great as is the danger from absorption of long obstructed bowel content.

* Read before the American Surgical Association, April 17, 1924.

MILES F. PORTER

SUMMERS¹ of Omaha and JUND and RANKIN² of the Mayo Clinic have recently published valuable papers on this topic. According to W. J. Mayo,³ Sir William Taylor "has had noteworthy success in handling acute obstruction of the bowels using enterostomy for the purpose of emptying the toxic contents of the bowel and of nourishing the patient." ORR and HADEN in a paper read at the 66th annual meeting of the Missouri State Medical Association on the "Treatment of Intestinal Obstruction" say "It is probable that we sometimes do a complete operation when an enterostomy would be the wiser procedure. In the very toxic cases the least operation possible to relieve the obstructed bowel, the better. If a bowel will not empty through a good enterostomy opening it will not empty through the natural bowel channel which has been relieved of the obstruction. If an operation for the complete relief of the obstruction, whether it be freeing of a constricted gut, a resection or an anastomosis, is not considered advisable, an enterostomy should be done.†

In previous communications I have cited cases illustrating the difficulty of distinguishing between malignant and benign disease of the hollow viscera even with the abdomen open. In the one case reported⁴ the pylorus was the part involved, and in the other paper⁵ four cases are reported wherein non-malignant disease of the colon was mistaken for malignant disease. In three of these cases recovery followed colostomy and in the fourth the growth was excised and an artificial anus made. In this case after the growth was found to be benign the artificial anus was closed. In the pyloric case a gastro-jejunosotomy was done as a palliative measure—which "palliative measure" proved curative and the patient reported himself well after four years and eight months. All of these cases were reported by members of this body, two by the writer and three by men of exceptionally high standing. James C. Masson of the Mayo Clinic regards the advice of Telling, Erdman and others to operate in all cases of diverticulitis as "most radical."⁶ Of the 289 cases diagnosed in this clinic only 116 were operated upon.

I have no hesitancy in predicting that in the near future resection for diverticulitis will be rarely done. Evidence is accumulating to prove that many cases of chronic diverticulitis of the sigmoid and rectum even with tumor formation and symptoms of obstruction can be cured by colostomy. That colostomy should usually precede resection in those cases demanding this latter operation is I assume an established surgical rule. How far the fear of malignancy should lead us in favor of resection as the treatment of choice in certain of these cases is as yet an open question.

Masson says that malignancy and diverticulitis are frequently associated and that the malignancy is no doubt the result of the infection. That colostomy is frequently postponed and in some cases permanently rejected, because of the disagreeable features it entails, to the great detriment of the patient is not an uncommon experience.

The disagreeableness of an artificial anus has been much exaggerated. Is there a surgeon within hearing who does not know of patients who were

† After this paper was finished I read Horsley's paper (Journal American Medical Association, April 12, 1924, p. 1159) in which he advises enterostomy after resection of the colon. He says: "Patients in whom the colon has been resected make a much smoother convalescence when this enterostomy is done."

THERAPEUTIC ENTEROSTOMY

subjected to a so-called radical operation for colonic or rectal cancer because of the "disgust and horror" which the thought of colostomy aroused in the mind of the patient or surgeon or both when as the sequence proved the minor operation offered much more hope for the prolongation of life and promotion of comfort? Colostomy properly done in properly selected cases adds to the comfort, contentment and pleasure of the patient. Gant⁷ reports that 70 per cent. of his colostomized patients have but one movement a day within a month after the operation. My aim in this paper has been to show that the danger and inconvenience of enterostomy have been exaggerated; while the benefits to be derived therefrom have been underestimated and that a correct valuation with consequent modification in surgical procedure would be beneficial.

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INTRA-ABDOMINAL RUPTURE OF INTESTINE FOLLOWING STRANGULATED FEMORAL HERNIA*

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BETTER understanding of the abuse of taxis and the crime of delay in strangulated hernia, together with the early recognition and prompt surgical intervention, have diminished the frequency of bowel gangrene and its direful sequelæ.

Many valuable contributions are found in the earlier literature telling the story of delay and describing intestinal "wet death" within the hernial sac, but in general there is little information to be found bearing upon that more serious complication mentioned in the title of this paper. A. J. McCosh,¹ in 1889 collected and tabulated one hundred and fifty cases for which immediate resection was done. C. L. Gibson's² statistical study based on "A Thousand Operations for Acute Intestinal Obstruction and Gangrenous Hernia," supplied a need at that time which had hitherto not been met. Neither of these interesting communications makes mention of an intra-abdominal rupture of the constricted gut.

A reference of historical interest from the writings of the English anatomist, John Hunter,³ bearing on this subject, which reflects his own wide experience, is worth quoting here. He writes:

"It is very curious to observe in hernias, that while the gut is in the sac and alive, no inflammation takes place within the sac or integuments; but the moment the gut becomes mortified or dead, the stimulus of an extraneous body takes place immediately; an outlet is then endeavoring to be made by the inflammation and suppuration of the sac, forming an abscess in it; which matter with the contents of the gut, is brought to the skin. While this is going on, the sound gut within the abdomen where it passes into the rings, adheres to those rings all round; so that when the abscess is formed, burst, or opened, and the mortified parts sloughed off, these ends of the gut open into the abscess, and not into the cavity of the belly."

In an effort to ascertain the frequency of a complete severance of the gut at the point of constriction within the abdomen, an abstract of the author's findings was sent to Sir Berkeley Moynihan, who courteously replied:

"I have had a number of cases of strangulated hernia in which the intestine has given way at the line of constriction. It has happened more often with femoral than with inguinal hernia. In their treatment, as a rule, the intestine is pulled down into the hernial sac, a resection made and an end-to-end anastomosis by suture completed. We have notes of three cases in which a fecal fistula was formed by merely laying open the adherent intestine in patients extremely ill. In two of these closure occurred after the spur between the two limbs had been destroyed by pressure. We have no note of any case in which fecal extravasation occurred into the peritoneum, as in your case."

W. B. Coley, whose wide experience at the Hospital for Ruptured and Crippled is well known, in a personal communication writes: "From my own

* Read before the American Surgical Association, April 17, 1924.

experience as well as my knowledge of the literature of hernia, I know of no case quite similar."

It is reasonable to assume that accidents of this character have been observed before; however, the literature available contains the record of but one case clearly belonging to this category. This was reported by T. H. Manley ⁴ before the Pan-American Medical Congress, November, 1896.

CASE I.—(Manley's case.) Male, Chinaman, aged twenty-eight years. No previous history of importance except a reducible inguinal hernia of the right side, of eight years' duration. No truss had been worn for three months. One morning the hernia descended and was more painful than usual; repeated efforts failed to reduce the mass. Medical aid was not sought for four days. The patient was in a state of grave shock and exhaustion when he presented himself for treatment.

Operation.—The sac was widely opened and found to contain a large quantity of dark offensive fluid, exposing a strangulated and gangrenous coil of the terminal ileum, completely severed at the distal constriction, about five inches from the ileocæcal junction. The wound was enlarged so as to freely expose the right lower abdominal quadrant. Foul-smelling fluid and contents of the bowel had been extravasated, and an acute peritonitis was in evidence. An immediate resection of twenty-six inches of the intestine was made and a lateral anastomosis performed, the Connell technic being employed. The upper part of the abdominal wound was closed, while the lower part, with the scrotal incision, was left wide open and packed loosely with gauze; no radical cure of the hernia had been attempted. The recovery of this remarkable case was uneventful.

CASE II.—C. W. G. Male, age fifty-seven years. Referred to the writer's service in the Ohio Valley General Hospital by Dr. Myron K. Reppard, November 12, 1919. For several years the patient had been subject to mild attacks of indigestion, and was conscious of an irreducible lump in his right groin. This lump was manifestly an incarcerated femoral hernia and was so diagnosed by his family physician. There was no other previous morbid personal history. Three days before admission he developed acute tenderness and pain in the right groin, with nausea, and persistent vomiting, and he then noticed an appreciable increase in the size of the protrusion. Efforts to move the bowels were fruitless and taxis was of no avail. The pain which was at first local became general and was described by the patient as "doubling up," and rendering him "unconscious."

Physical Examination.—The patient was a poorly nourished white man, appearing ten years older than his fifty-seven years. The countenance was drawn and anxious, skin moist, pulse frequent and small, respirations shallow and costal. He lay with his knees drawn up, apparently free from pain, except on palpation of the abdomen. There was entire absence of splenic and hepatic dulness. Over the right saphenous opening there could be felt a protrusion, immovable and semifluctuant, and about the shape and size of an egg. There was absolute stomach intolerance, the ejecta was brownish and foul. The clinical picture was obviously one of strangulated femoral hernia, associated with peritonitis. While this of itself was grave enough from the beginning, it was further complicated by shock, which had suddenly developed in the course of an extremely rough trip of seventy miles while in transit from his home to the hospital. The imperative necessity for immediate surgical interference was obvious.

Operation.—A preliminary gastric lavage was done. Under nitrous-oxide and oxygen and local blocking an incision over the protrusion was made. This revealed a loop of lustreless, black and lifeless gut, about 10 cm. in length. A foul-smelling, dark-colored fluid, containing fecal matter, escaped from the sac. At the point of constriction one end of the devitalized loop was wide open, and the segment from which it was separated was nowhere to be seen. The constriction was divided and a liberal incision made through the rectus muscle, freely exposing the right iliac fossa. The open and retracted

proximal end of the terminal ileum was then identified. It exhibited a sharply defined area of pressure necrosis and an extension of the gangrene about 3 cm. beyond the point of rupture. The adjacent mesentery was thickened, with evidence of clotting in the vessels. The abdominal cavity contained fecal matter, free fluid and gas, and the presenting intestinal coils were studded with a fibro-purulent exudate, confined for the most part to the right lower abdominal quadrant. The distal end of the gut with the gangrenous loop was withdrawn through the femoral ring. Fourteen centimetres of the ileum were resected at a point 45 cm. from the ileocecal junction. A precautionary mattress suture was inserted, followed by an end-to-end reunion of the intestinal continuity, by the use of a Murphy button. The cut edges of the mesentery were approximated by interrupted sutures of fine chromic gut. After a careful peritoneal toilet, and well-directed drainage, the abdominal incision was partly closed. The original incision over the hernial protrusion was loosely packed with washed iodoform gauze. Inspection of the resected segment of gut showed two small ulcerations about $1\frac{1}{2}$ cm. in diameter; one within the lumen and a second distal to the constriction. The ulcers were not perforated.

Progress of the Case.—The patient responded to measures directed against the shock. The presence of hiccough was an embarrassing feature for twenty-four hours, but it finally yielded to gastric lavage. There was a gradual abatement of all distressing symptoms, and a free evacuation of the bowels on the fourth day. The patient's convalescence was uneventful, and he was discharged well from the hospital on the twentieth day. The button was passed on the thirtieth day and he has continued in good health to the present time.

Mechanical Devices in Anastomosis.—In the light of the increasing opposition to the use of mechanical aids in effecting an intestinal reunion, perhaps some apology is due for the selection of the button in this instance.

Thirty years ago Caird⁶ of Scotland observed that the best results in surgery of the intestine could be gained with needle and thread; and he prophesied that many of the ingenious inventions employed in uniting the bowel would share the fate of the too greatly neglected device of Quatre Maitre, who, in the 13th century, employed a calf's trachea for a purpose similar to that which led Ranke to use a tallow candle and Senn to employ decalcified bone plates. Certainly no protest need be made when the gravity of the case demands speed, if the Murphy button forms a part of the emergency equipment, even though we concede with Moynihan that all mechanical devices "have now no more than an historic interest."

Primary Reunion or Artificial Anus.—One's first impulse in such an emergency is to make an effort at conservation of the patient's resources, and to establish an artificial anus, rather than add further to the already exhausted invalid by any tedious sewing. When planning for this less serious procedure it is well to remember that the patient must later be subjected to an operation having a mortality of 27 per cent. (Gibson), in the restoration of the continuity of the gut, and that the making of an artificial anus is but "one step on a perilous road to recovery," as Singly has so fittingly put it. On the other hand, it must be remembered that immediate primary union, when properly done, consumes little, if any, more time, whether effected by suture or by a mechanical device. Gibson, in a very complete résumé, quoted by Johnson,²² found in one hundred and one cases in which an artificial

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anus was formed there were fifty-three deaths, a mortality of 52.5 per cent. In 226 cases in which primary resection and reunion of the intestine was made at the time, there were 58 deaths, a mortality of only 26 per cent. Further supporting this contention is the interesting fact that the elder Kocher and Mikulicz were ardent champions of primary resection, while Coley's⁶ statistics, collected from six of the larger clinics, and based on an analysis of 3268 cases, show a mortality of 23 per cent. in favor of immediate reunion. However, on last analysis each case must be determined on its own merits.

Infrequency of Femoral Hernia in the Male.—Regarding the infrequency of femoral hernia in the male, in 61,561 males with hernia in the groin, reported by Gibson² from Maydl's series, 2362 were femoral, or as 1 to 25. Hoguet⁷ in giving his observations on 2468 hernia operations, found but one case of strangulated femoral hernia in the male.

Ulceration, Gangrene or Perforation of the Bowel Beyond the Hernial Constriction.—Whipple⁸ and his associates attribute the overwhelming depression and death in these cases of obstruction, to an excessive breakdown of tissue protein due to the absorption into the blood of a toxic proteose. Lynch¹⁰ Werelius⁹ is inclined to the opinion that it is a liver inefficiency or a cessation of bile secretion, which has a direct bearing on the mortality factors. Lynch¹⁰ and Draper¹¹ and Eisburg¹² contend that the lethal agent is due to an interference with the internal secretory function of the epithelial cells of the gut itself, rather than to bacterio-toxic causes, or of biochemical origin similar to parathyroid or other endocrine secretion. Moynihan¹³ has written that the mechanical impediment to the onward flow of intestinal contents is not so much the cause of the collapse of these patients, as the overloading, distention, and the ulceration of the gut above the block, together with the absorption of contents whose bacterial virulence is greatly increased. The last thought opens up a new field, as the ulceration beyond or proximal to the constricted loop, to which the distinguished English surgeon refers, goes on to perforation and fatal peritonitis, unless promptly recognized and relieved. The literature contains several timely reminders of this type of hernial complication, and as some of the cases so nearly parallel the author's report, with your indulgence, they will be included in this discussion.

CASE I.—S. HIDA,¹⁴ while operating for a strangulated inguinal hernia, found the bowel in the hernial sac black and devitalized. The compression anæmia and gangrene were found to extend six centimetres above the seat of the constriction and in this area, above the stricture, there were two perforations, and a generalized peritonitis. Thirty-six centimetres of the bowel were excised and anastomosis made by suture. Repair of the hernia was effected by the Bassini method, and the patient made an uninterrupted recovery.

CASE II.—GOODHART¹⁵ describes a case in a woman aged forty-four years, who was operated upon in Guy's Hospital, London, for a femoral hernia, in 1879. Readmitted two years later, because of recurrence of the hernia and persistent vomiting. She was operated upon again, a mass of omentum being removed and the stricture divided. She died twelve days later, the abdomen becoming distended and painful; the temperature was normal until the day before death, then rose to 102° F. The knuckle of bowel involved in the hernia was close to the cæcum. At autopsy an ulceration affecting 12 to

13 feet of bowel extended upward from the incarcerated bowel, which was not ulcerated. The ulcers were arranged in clusters forming more or less circular patches, extending all around the bowel, though more mesenteric than otherwise. The cause of the ulceration could not be determined as no obstruction to the circulation could be found.

CASE III.—In a review of 1500 inguinal hernia operations at the Massachusetts General Hospital, Boston, Mass., LINCOLN DAVIS³⁶ notes that there were eight deaths. One of these was a case of double hernia, in which abdominal pain, distention and vomiting developed after the hernia operation. At a second operation on the eighth day perforated ulcers of the colon were found. Necropsy showed no direct connection between the hernia operation and the peritonitis, which was evidently the result of the perforation of the intestinal ulcers.

CASE IV.—SELLENINGS³⁷ reports two cases in which perforation above the hernia occurred prior to operation. In one case the patient was a woman with a history of left-sided inguinal hernia of many years' standing, for which a truss had been worn. The hernia became irreducible and very painful, but within a few hours the patient reduced the mass herself. After the reduction she felt severe abdominal pain, chiefly in the region of the umbilicus, vomited several times and was prostrated. The temperature was 101.6° on admission to the hospital; the abdomen was distended, rigid and tender. At operation a round, solitary perforation of the ileum was found, and about eight to ten inches distal to the perforation the gut was contused, showing signs of recent strangulation. The perforation was sutured, but the hernia was not repaired, owing to the patient's condition. The patient vomited frequently during the first few days after operation, but made a good recovery.

CASE V.—SELLENINGS' second case occurred in a man who had a right inguinal hernia for two years and had worn a truss. On the day of admission to the hospital the hernia came down into the scrotum, and was painful and tender. He also had colicky pains in the abdomen but did not vomit. The abdominal pain became very severe and he was sent to the hospital during the night; the abdomen was moderately distended, rigid and tender, especially around the umbilicus. The scrotal tumor was painful on pressure, but was reduced by manipulation. Temperature 102.8° F. At operation a single perforation was found in the intestines similar to the one in the previous case. The gut distal to this lesion showed no gross alteration indicating that the compression had not been so great as in the first case. The perforation was sutured; the hernia was not repaired; the patient recovered.

CASE VI.—MACNAUGHTON³⁸ reports a case of left inguinal hernia in which no attempt at reduction was made. The patient was relieved by hot fomentations and the administration of morphin followed by a small enema, which caused a movement of the bowels. Later the patient became restless, and fainted when attempting to sit up; the pulse was weak; the extremities became cold, and he died in a few hours. At autopsy an irregular transverse rupture was found in the small intestine in the left lumbar region; for fully four feet below this level the ileum, until it passed into the hernial sac, contained blood and mucus. The hernial sac contained nearly three feet of healthy small intestine, the cæcum with an elongated vermiform appendix, five inches of the ascending colon, and a considerable portion of the mesentery; there were no signs of strangulation.

CASE VII.—MOIR³⁹ reports a case in a man who had had inguinal hernia for six months, for which he wore a truss. On the night prior to admission to the hospital the hernia had come down and could not be as easily reduced as usual. The patient finally succeeded in reducing it, and almost immediately after felt abdominal pain and vomited. When admitted to the hospital the next day the abdominal pain was severe, and the patient was in a state of collapse. At operation a perforation in the small intestine was found, and below it a slight constriction of the gut. The perforation was sutured, a careful toilet of the peritoneal cavity made, and a drainage tube inserted into the pelvis. The patient did not rally and died about four hours after the operation.

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CASE VIII.—J. F. ERDMANN²⁰ reports a case of non-reducible umbilical hernia in a young woman who had a history of abdominal pain, distention, and hiccough persisting for about a week. At operation, the intestines above the hernia were found to be matted together, and a slough was found at the proximal and the distal end of the jejunum. Ten inches of intestine were excised and suture anastomosis made. The patient made a good recovery.

In presenting this subject THEODORE KOCHER²¹ suggested the possibility that in strangulated hernia, as in other forms of bowel constriction, the intestinal wall above the lesion may be involved. He believed this was due primarily to venous stasis coming from an interference with the circulation, thus decreasing the resistance of the mucous membrane to the invasion of bacteria and leading to ulceration, or even to perforation.

This ulceration of the mucosa, whatever its cause, seems to present a definite pathological entity, and we believe that a note of warning should be sounded against any anastomosis being attempted in a case of strangulated hernia with gangrene, without first carefully inspecting the two segments of the gut, with reference to the integrity of the mucous membrane.

The various theories advanced regarding the lethal agent coming as a sequel of intestinal block, whether it is the ulceration or trauma of the mucosa, suggested by Moynihan, dehydration, proteose intoxication, or the invasion of hæmolytic bacterial flora. Each has its supporters, and valid reasons have been presented, based on painstaking research. Whatever the source of the complex biochemical formula, whose venom will produce a clinical picture so grave and a pathology so destructive, we do know that it makes speedily for *exitus letalis*, unless promptly recognized and relieved.

In conclusion, it may be mentioned that in dealing with a strangulated hernia, with death of the bowel, there are at least two mortality factors to be considered in addition to the shock occasioned by the intestinal block:

First.—The possibility of an intra-abdominal leak, due to a partial or a complete rupture at the point of the constriction from pressure necrosis.

Second.—There may be further added a definite pathologic entity in the form of an ulceration of the gut, leading to a post-operative perforation. That this accident has been recorded with increasing frequency, and this fact should lead to a searching interrogation of the mucous membrane immediately adjacent to or beyond the line of anastomosis, in order to forestall a potential leakage.

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THE ADDITIONAL POSTERIOR INCISION IN CERTAIN CASES OF OPERATION FOR THE INFLAMED RETROCÆCAL APPENDIX*

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THERE can be no question that it is to the advantage of the patient under operation, if the surgeon can see plainly what he is doing. Starting from this premise, I have made it a rule in my personal work, even as far back as the early times of the evolution of the appendix chapter, thirty years ago, to expose to view the inflamed organ in its entire length in the course of its extirpation. I never practiced the method of working through a small incision and trying to separate adhesions bluntly by the mere sense of touch, when operating for appendicitis.

I have applied this rule also to the so-called retrocæcal appendix, when the latter is tied down and cannot be brought into view by any kind of manipulation.

In this type of cases I have found it expedient, and to the best interest of patient as well as surgeon, to abandon the anterior incision, para-rectal or per-rectal, and add a posterior one which exposes the retrocæcal and retrocolonic space.

If McBurney's intermuscular operation had been in progress, then the additional posterior incision was made a part of the former.

Every surgeon has met with instances in which the appendix could not be brought forward and properly exposed for the usual tying of the meso-appendix and consecutive steps. He then follows downward to the cæcum the presenting longitudinal band of the ascending colon. But not infrequently just the very base of the appendix alone appears, its further course, for the moment, is not discernible. Then, on lifting the caput coli with the left hand and slipping the right forefinger around the cæcum we often feel the mass behind the gut. In many cases when the organ lies entirely within the

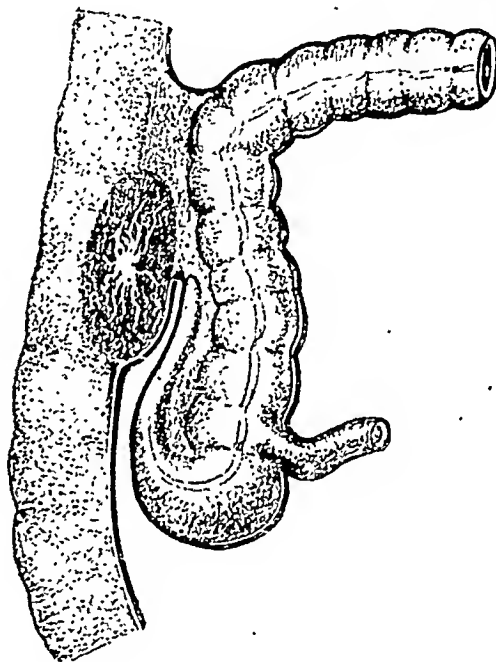


FIG. 1.—Reproduced from G. S. Huntington, I. c. Tip of retrocæcal appendix reaches level of right kidney, but is completely covered with peritoneum. In such an instance the surgeon usually is able to mobilize the inflamed organ and make its distal end appear alongside the ascending colon.

* Read before the American Surgical Association, April 17, 1924.

peritoneal cavity (Fig. 1)† we succeed in pushing it forward and bringing its tip into view, which then renders easy the completion of the operation. In other instances the manoeuvre is unsuccessful. Inflammatory bands of old standing are unyielding; firm adhesions make the appendix absolutely immovable, it forming a unit with the intestine, or congenital anatomical relations hold it fixed posteriorly (Figs. 2 and 3).

In such an emergency, in acute and sub-acute as well as chronic cases, the surgeon has to decide quickly as to the best and safest procedure in the given case.

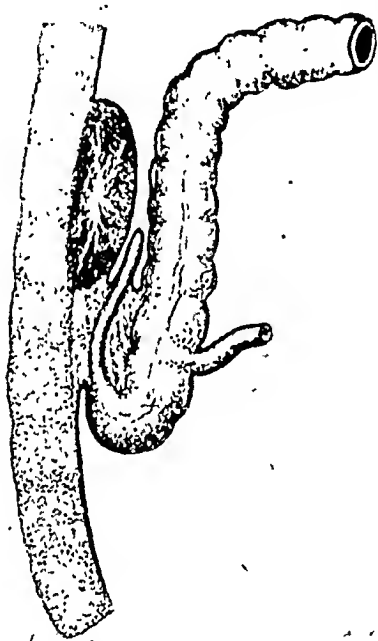


FIG. 2.—See G. S. Huntington, l. c. The greater portion of the retrocaecal appendix, commencing at its base, runs upward toward the kidney within the retroperitoneal tissue, its distal third, however, is situated within the general peritoneal cavity, a fold of peritoneum, descending from above, covering it all around.

Personally I believe it is to the patient's interest not to insist upon forcing the further steps of the operation by way of the original incision, but to place a sand-bag under the patient's right hip and proceed as follows: map out the middle between McBurney's point and the anterior superior spine by placing thumb and third finger on these two points and the forefinger upon the centre of the imaginary line, connecting the umbilicus with the anterior superior spine, and from here make a second incision upward through the skin toward the region of the kidney, about $2\frac{1}{2}$ to 3 inches long (Fig. 4). After dividing the fascia of the external oblique muscle and its muscular substance in the same direction, the

fibres of the internal oblique are cut across, bleeding vessels being immediately caught and tied. Transverse fascia with parietal peritoneum appears, in stout patients clearly marked by a layer of fat; they are also cut. Now the retrocaecal and retrocolonic space has been opened and its condition can be explored under the guidance of the eyes. Usually I have made this wound of the abdominal parietes funnel-shaped, the deep incision shorter than that of the skin, in order to cut across as few fibres of the internal oblique as possible. I always open the peritoneal cavity in the lower angle of the wound, because the entrance into the peritoneal sac at this place is assured. According to requirement the whole incision can be lengthened upward in the course of the further work. With the borders of the wound well held apart by means of broad blunt retractors, the appendix usually comes quickly into view and can now be followed up in its entire course to its tip, and be safely

† Ileocaecal folds and fossae in George S. Huntington, *The Anatomy of the Human Peritoneum*. Plate cclxxx, p. 272.

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and correctly dealt with. For the effect of the additional posterior incision it is immaterial whether the appendix is completely or only partially located intraperitoneally. The point is, to be able and expose the organ in its entirety, irrespective of its length and course. That can be nicely accomplished with the help of the additional posterior incision.

If McBurney's intermuscular operation had been done, the posterior incision starts from the middle of the superior lip of the transverse muscular and peritoneal wound and runs from there upward (Fig. 5), the inner and outer end of the original peritoneal incision having been marked by clamps which are left temporarily in place. Drainage of the posterior wound is done according to general rules. If in acute or subacute cases pus was encountered, due to gangrene, with an infiltrated meso-appendix, the cigarette drain will be a safeguard, as in other cases of acute appendicitis, and the desired drainage is facilitated on account of the directly downward course of the canal, the patient being on his back. In the absence of gangrene we close up completely by means of layer sutures. The anterior wound is always closed airtight.

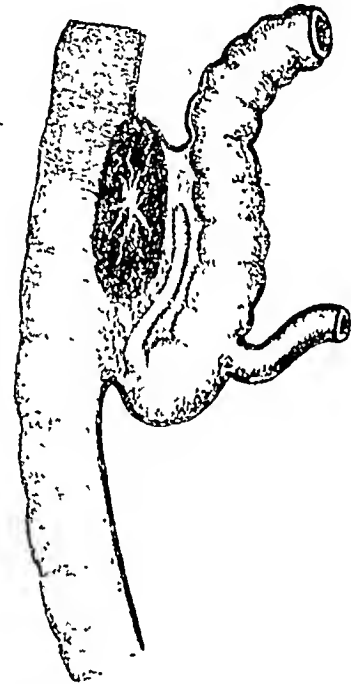


FIG. 3.—Also copied from G. S. Huntington, l. c. The entire long retrocæcal appendix is situated outside of the peritoneal sac; its tip again reaches up to about the middle of the kidney. Blunt manipulation from within the peritoneal cavity, without guidance of the eye, must necessarily represent a hazardous surgical procedure.

I first mentioned this procedure, which I did not find described in the literature when discussing Dr. A. S. Vosburgh's paper, "Non-rotation of the Intestine; Its Relation to High Retrocæcal and Aberrant Position of the Appendix," read before the New York Surgical Society on October 9, 1912 (*ANNALS OF SURGERY*, December, 1912). Later on I elaborated on it in the "Festschrift," dedicated to Prof. F. Trendelenburg by his former assistants and his successor in the Chair of Surgery at the University of Leipsic on the occasion of his seventieth birthday ("Zur Chirurgie des Wurmfortsatzes," *Deutsche Zeitschr. f. Chir.*, vol. cxxix, p. 321, 1914). On November 5, 1920, I read a paper on the same subject, entitled "A Safe and Simple Method for the Extirpation of the Adherent Retrocæcal Appendix" before the Surgical Section of the New York Academy of Medicine. This has not been published so far. A recent instructive personal experience brought the value of the additional posterior incision, as above described, again forcibly to my mind and impelled me to write this paper and discuss the method before our Association. I prefer not to cite this last case in spite of its many points of interest, because it was somewhat atypical and did

not, owing to pathologic peculiarities encountered, show *all* the advantages of the additional posterior advance, as I had seen them in previous experiences. I shall therefore pick out for illustration just a very few cases from a series of upward of thirty of this type, that have been operated upon by me on basis of the above-cited plan within the last twenty-eight years.

According to my personal records, the additional posterior incision for an adherent retrocæcal appendix was done by me for the first time in 1896. As a matter of evolution variations of the operation were developed according



FIG. 4.—Showing the two incisions as used by the author in cases of adherent retrocæcal appendix which cannot be properly reached and loosened from the front. The one nearest the middle line represents the typical paracætal incision, which is abandoned in case of necessity, the second then being added; the lower end of the latter corresponds to the middle between McBurney's point and the anterior superior spine and then runs backward and upward as long as required, dividing the muscles sharply.

to the character of the inflammation—acute, sub-acute, chronic—as well as to the possibility of a correct diagnosis previous to operating regarding the position of the inflamed organ; that is to say, in a number of instances access was gained by means of the posterior incision primarily, sharp through all the muscles, or by the intermuscular approach, at the place and in the direction mentioned above for the additional posterior incision, or by a high intermuscular approach according to McBurney (Fig. 6) leaving out the preliminary entrance into the abdominal cavity from the front. The variations are:

1. Anterior incision with additional lumbar cut;
2. McBurney's intermuscular operation with additional sharp incision backward and upward from the middle of the upper lip of the musculo-peritoneal wound;
3. Primary McBurney intermuscular incision, high above the omphalo-spinous line, without the necessity of an additional posterior incision;

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4. Primary posterior sharp incision through all the three muscles constituting the abdominal wall.
The two latter varieties will not be discussed here.

CASE I.—*Para-rectal or per-rectal incision plus additional lumbar incision.* Male, forty-eight years. In May, 1904, sudden severe colic, rectospasm, vomiting. Admitted to the Lenox Hill Hospital, ten hours after the onset of the attack.
Operation.—Para-rectal incision; appendix not found; incision lengthened upward; cæcum high; insertion of appendix exposed, runs in retrocæcal direction; extensive adhe-

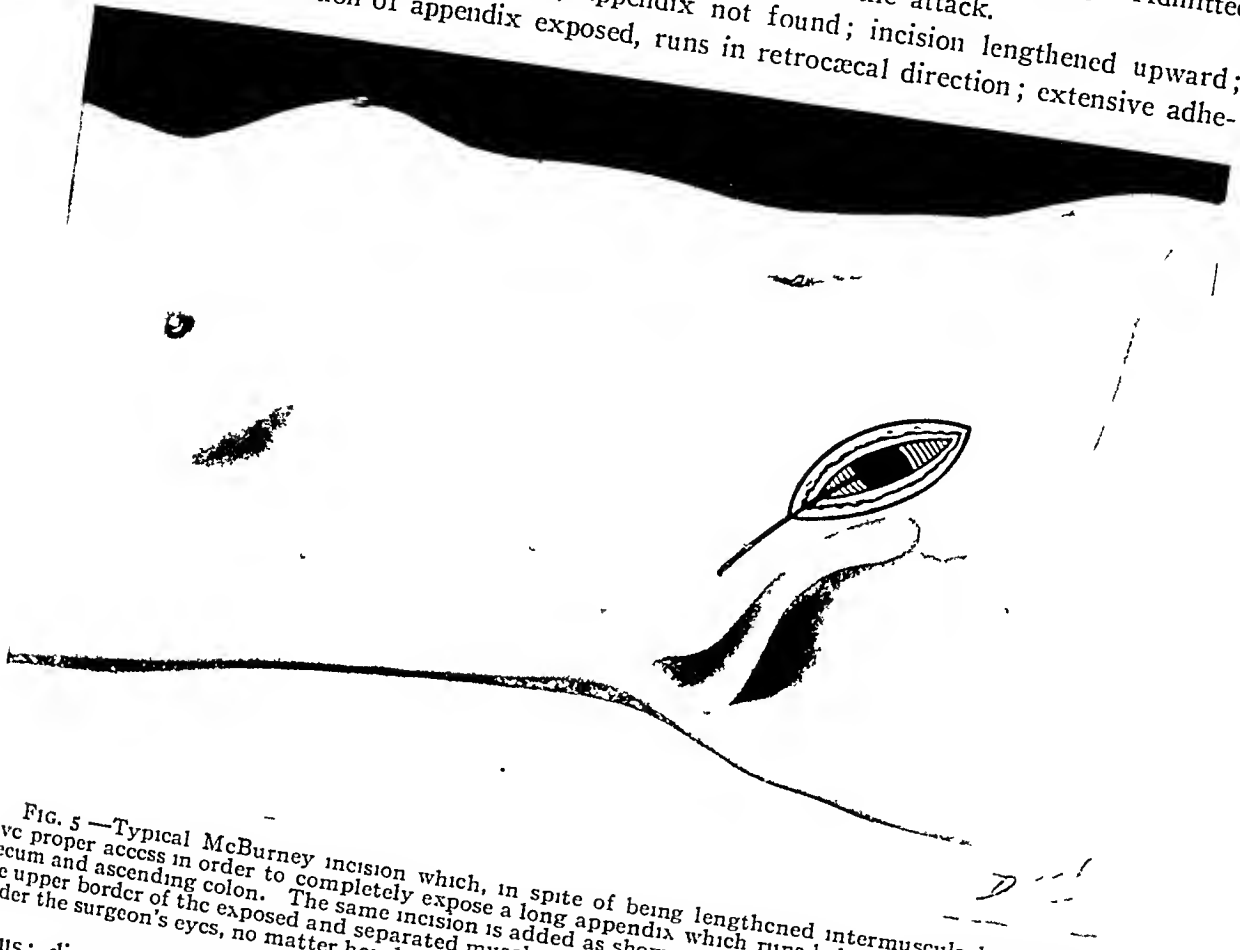


FIG. 5.—Typical McBurney incision which, in spite of being lengthened intermuscularly, does not give proper access in order to completely expose a long appendix which runs behind of and upward with cæcum and ascending colon. The same incision is added as shown in Fig. 4 commencing at the middle of the upper border of the exposed and separated muscle substance. It will permit to do any work required under the surgeon's eyes, no matter how long, twisted and adherent the appendix.

sions; discontinuance of operation by this route; temporary tamponade; right side of pelvis raised upon sand-bag; sharp incision backward through the three muscle layers (as above described), which had gradually to be lengthened to the anterior tip of twelfth rib; with a second cushion placed under the lumbar spine, producing pronounced lordosis, the entire very long appendix comes finally into view; from its insertion into the cæcum it turns backward and upward toward the renal region; thence toward the middle line and from there downward again close to its starting point, thus describing about nine-tenths of a circle. Ligation of old strong adhesions step by step; appendectomy; suture of wound; cure.

CASE II.—*Perforative gangrenous appendicitis.* Female, thirty-five years. Great sensitiveness over McBurney's point, extending upward toward border of liver. Admitted to Lenox Hill Hospital, October 27, 1905. Para-rectal incision; peritoneal cavity filled with pus; appendix does not come into view on pulling upon cæcum. It is therefore assumed that the organ is located retrocæcally. Appendix seen at once; very long; firm adhesions to posterior surface of ascending colon; tip near liver found to be gangrenous and perforated; suture with drainage; cure.

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CASE III.—*Acute gangrenous appendicitis*. Male, twenty-seven years. Seriously ill for twenty-four hours; tenderness posteriorly and in front; some rectospasm. Admitted to Lenox Hill Hospital, May 20, 1919. Immediate operation: Para-rectal incision; only base of gangrenous appendix visible; organ retrocaecal and firmly adherent; additional posterior incision exposes a totally gangrenous appendix; removed without breaking the organ; anterior and posterior cut closed; rubber tissue drain in upper end of lumbar wound; uninterrupted recovery.

CASE IV.—*McBurney's blunt intermuscular incision with additional sharp incision backward and upward from the middle of the upper lip of the muscular wound*. Boy,

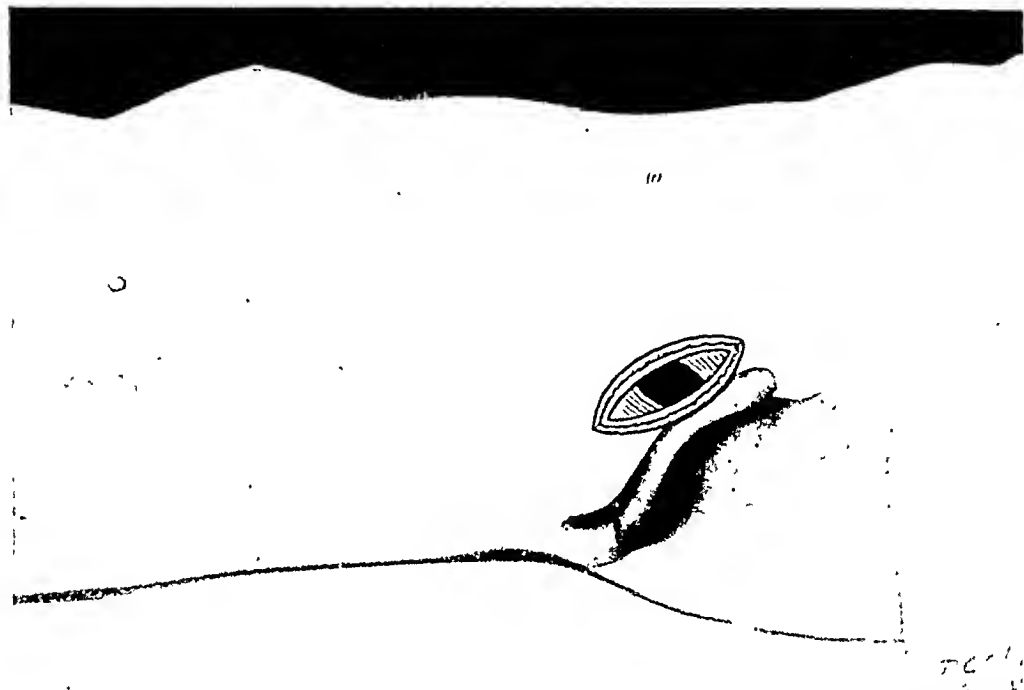


FIG. 6.—A high McBurney incision; the lower end of the wound corresponds to the omphalosplenic line. It will permit to thoroughly expose to the inspection of the surgeon the appendix which is situated retrocaecally, provided it does not run too far upward, and caecum with colon are movable. If need be, the upward sharp incision can be added as shown in Fig. 5.

twelve years; interval operation at Lenox Hill Hospital, May 14, 1901. McBurney's blunt, intermuscular division; caecum not found, even after placing patient in Trendelenburg's posture; intermuscular incision continued inwardly (Weir); wide access; sigmoid flexure to the right; caecum away up, tightly adherent; appendix runs posteriorly and upward, equally firmly adherent; impossible to reach for good surgical work; therefore posterior incision through muscles added; organ now fully accessible; thickened firmly adherent to intestine and omentum; loosening; excision; suture; cure.

CASE V.—*Acute appendicitis*. Male, twenty-five years. Two weeks previously peculiar attack of intra-abdominal inflammation. Diagnosis of appendicitis doubted by attending physician on account of the alleged absence of tenderness over McBurney's point. Moderate sensitiveness posteriorly at time of consultation. Diagnosis: Appendicitis; organ situated posteriorly. Operation, December 12, 1906, at the Lenox Hill Hospital. Blunt division of muscles (McBurney) above anterior superior spine; appendix does not come into view; finger palpates organ tightly adherent posteriorly; on attempting to loosen it, pus appears; incision lengthened inwardly (Weir), good access; but appendix cannot be reached as yet; closure of inner two-thirds of wound; sharp division of muscles posteriorly and upward, with sand-bag under right half of pelvis. It becomes evident that a perityphlitic abscess had advanced posteriorly into the lumbar

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muscles, the suppurating canal being about two inches long; appendix itself very short, funnel-shaped at insertion near cæcum, contains thin fæces; excision; drainage; recovery.

Of course, the surgeon can try in cases of this type, to do away with the sharp division of the posterior abdominal wall in one and the same line and proceed by means of a high placed McBurney's intermuscular operation with Weir's addition, for a wide exposure is usually required. However, cases will be encountered as I have just described them, where the cæcum is situated so high that even a *very* wide intermuscular approach will still be found insufficient and the sharp division of the muscles upward will become imperative. And it may be done without hesitancy, because neither important nerves nor blood-vessels are cut. Personally I have not observed a subsequent abdominal hernia in a single instance, even when, in former years, wide drainage with gauze tampons was done. The careful suture of the wound in layers with the insertion of a cigarette drain or a twisted piece of rubber dam, as practiced nowadays, makes the development of an abdominal rupture well-nigh impossible. In one of the cases the local tonus of the abdominal wall was found to be impaired, evidently on account of the division of branches of the twelfth intercostal or the ileo-hypogastric nerve which cross the field; here the right hypogastric region was somewhat bulging for a while, but a hernia did not develop. Such sequelæ, of course, can sometimes not be avoided and must be faced, when difficult, life-saving work is to be safely carried out.

In emergencies, such as described, some surgeons practice primary division of the base of the appendix, as mentioned above, and after proper attendance to its stump, follow the course of the organ toward its tip. I have tried this myself, but cannot see any advantage in such a course. It certainly is always the better plan to try to work from the tip to the base and after complete exposure make the division of the base of the appendix the last step of the operation. In particularly difficult cases this procedure will also not lead to a successful removal of the entire appendix, except the parietal peritoneum alongside the large intestine is divided. Others abhor the idea of making a second abdominal incision in an operation for appendicitis, no matter how complicated the case may prove to be. They cut through the fold of the parietal peritoneum parallel with and on the outer side of cæcum and ascending colon. This allows the operator to pull the large intestine inward and turn its posterior side up. However, it seems to me that this procedure is far less advantageous for the patient, surely less advantageous in case of acute gangrenous inflammation of the retrocæcal appendix with perforation and pus formation. Such an incision along the outer side of the gut enters the retroperitoneal space and is bound to open new avenues for absorption and possible additional infection at a time when the intense inflammation present. Besides—and this is the principal drawback—such incision intentionally unites the general peritoneal cavity, which in some cases

so far was but slightly or not at all involved, with the region of the source of inflammation. Whereas, by adding the second, posterior incision, we reach the focus of intensest disease by the shortest and most direct route. We are able to loosen and remove the appendix, no matter how long and twisted it may prove to be, with ease and precision, watching every step, without coming in contact with the general peritoneal cavity, and we can drain, should this appear necessary, in a most direct and natural way.

Proceeding as above described, the surgeon will often be surprised to observe how the removal of a firmly adherent inflamed retrocæcal appendix which, at first glance, appeared to be a difficult and complicated task technically, with one stroke becomes transformed into a comparatively easy and safe operation.

AN EXPERIMENTAL CONSIDERATION OF THE INFECTION
OF PERMANENT HYDRONEPHROSES*

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AND

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THE underlying cause in the development of a hydronephrosis is generally recognized to be any factor that causes obstruction to urinary outflow from the kidney or ureter. This obstruction may be complete and constant, in which event a permanent hydronephrosis develops, or it may be transient or incomplete when an intermittent or moderate hydronephrosis is present. In either event, the obstruction to free urinary outflow is one of the chief factors in causation of infection of the urinary stream, it being necessary only to add the offending organism to produce the picture of a urinary tract infection of mild or severe type. In view of the many and varied causes of hydronephrosis, varying from an aberrant renal vessel or a congenital ureteral valve to absolute obstruction of the ureter, it is the purpose of this paper to study some of the factors which may be of importance in converting a relatively harmless hydronephrosis into a pyonephrosis.

In order to have a fixed condition to study, we have elected to consider infection of hydronephroses due to complete obstruction of the ureter rather than the intermittent or incomplete types, though the principles governing the infection of all types are more or less the same. Clinically, the permanent hydronephroses are usually due to accidental or purposeful ligation of a ureter during an operative procedure in the pelvis, pressure on the ureter from inflammatory masses or any growths, stricture of the ureter, obstruction by stone, products of inflammation or congenital anomalies.

Barney¹ was able to collect 46 cases from literature where ligation of the ureter had been performed. Ten of these patients recovered without symptoms of any sort. Thirty of the patients recovered after a stormy convalescence which required nephrectomy in seven of them. Six of these patients developed an infection of the hydronephrosis which required the nephrectomy. As these cases are rather difficult to find in literature and complete data was present only in the operative cases that required nephrectomy, the fate of the kidneys in the remaining thirty-nine cases is problematical. From the standpoint of our subject it is of great interest to know that about 15 per cent. of the cases of accidental ligations of the ureter in patients resulted in infection of the hydronephrosis. From the experimental standpoint, a great deal of data is not available as to the spontaneous infection of hydronephrosis after simple ligation. In some work of our own, where ligation and division of the ureter had been accompanied by division of the cord at different levels,

* Read before the American Surgical Association, April 19, 1924.

we frequently had infection of the hydronephrosis, when the operative wound over the spine became infected. We were able to ascertain that as a rule the

organisms found in the pyonephrosis were those which were present in the wound infections of the back.

In the case of five other dogs who died after ligation of the ureter in a period varying from eight days to two months after the ligation, and in which no conditions had been introduced to favor infection of the urinary stream, spontaneously developing pyonephrosis was found in two. One of these dogs died of distemper four weeks after ligation of the ureter. Fine bacilli commonly found in distemper animals were isolated from the hydronephrosis. In the other animal dying two months after ligation of the ureter, Gram-positive bacilli and Gram-negative cocci were found in the pyonephrosis. In contrast, an animal dying of pneumonia five weeks after ligation of the ureter, had a sterile hydronephrosis.

These few clinical and experimental observations are of importance in that they show that the infec-

tion of a complete hydronephrosis occurs in a definite percentage of cases.

The experiments to be discussed in connection with this problem will consider contiguous intraperitoneal infections as well as the relation of the bowel and blood stream to infection of hydronephroses.



A



B

FIG. 1.—Dog 7-7. Twelve-hour hydronephrosis after ligation of ureter. A. Normal kidney. B. Beginning hydronephrosis.

Ascending Infection of a Possible Route for Infection of a Hydronephrosis.—The description of well-defined lymphatics in the wall of the ureter connecting the bladder and kidney has served as an argument to establish the premise that kidney infections may result from the infection travelling from the bladder to the kidney by way of the ureteral lymphatics. I believe this rarely happens and that the lymphatic drainage of the urinary tract is segmental, the bladder and lower ureter draining into the hypogastric glands and the upper ureter and pelvis of the kidney into glands along the vena cava near the hilum of the kidney.²

If, however, due to accidental ligation and division of the ureter in the course of a pelvic operation the stump of the ureter comes in contact with infectious material, the possibility of infection of the developing hydronephrosis

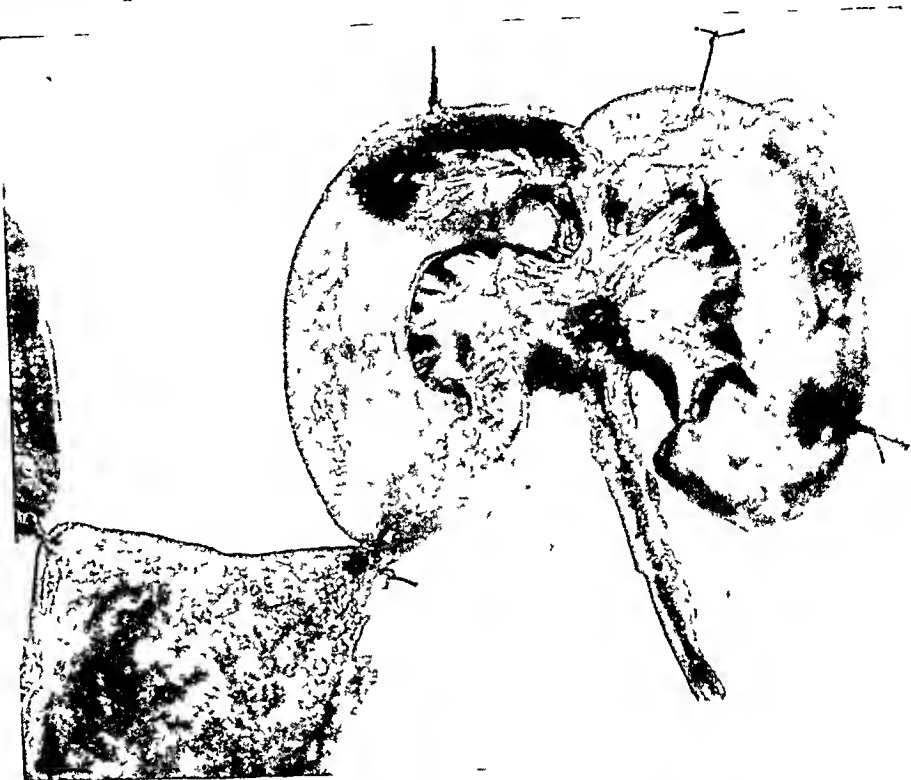


FIG. 2.—Dog 20. Five-day hydronephrosis after ligation of the ureter.

arises. This infection theoretically may involve the kidney by ascending infection through the ureteral lymphatics, by direct extension of the infection through the ureter or by involvement of the blood stream.

To establish experimental conditions which would enable us to evaluate these possibilities, sixteen dogs, whose urine was known to be sterile, were used. In some of the animals a plastic exudate on the peritoneal surface of the bladder was induced by the colon bacillus. The ligated divided ureter became adherent to this plastic exudate on the bladder in several dogs. These dogs were sacrificed from four to twenty-three days after the experiment had started. The post-mortem revealed a sterile hydronephrosis in six dogs, although a rather marked polymorphonuclear exudate was present in the peri-ureteral tissue around the blood-vessels, frequently reaching to the sub-pelvic kidney fat. In two other dogs (6 days and 23 days) *B. coli* pyonephrosis had developed, though the opposite kidney urine, as well as the blood stream, was sterile. In these experiments the obvious inference is that the cut surface of the ureter coming in contact with infectious *B. coli* exudate resulted in an ascending infection which in two dogs resulted in a pyonephrosis.

In contrast to these experiments are those in which a piece of gauze saturated with *B. coli* was wrapped around the undivided ureter. In these

experiments very little or no evidence of involvement of the ureteral lymphatics was found and the urine in the kidney remained sterile. In other experiments, where a pelvic abscess was formed about *B. coli* impregnated gauze, and the ligated cut end of the ureter was incorporated in this abscess, pyonephrosis was usually present after two to four weeks. In these animals it

was difficult to say whether the infection had been caused by direct extension of the infection by continuity, or had spread to the kidney urine *via* the lymphatics, or was the result of a blood stream infection. My impression is that lymphatic involvement was not responsible for the infection in this group of animals.

In general, it may be said that a hydronephrosis developing because of a ligated, divided ureter may become infected *via* the ureteral lymphatics if



FIG 3 —Dog 11 Six-day hydronephrosis after ligation of ureter and control kidney (A)

the cut end of the ureter is in contact with infectious material. I do not believe that this route is a common one or that it compares in frequency to infection of the urinary tract by other routes.

The Relation of the Bowel to B. Coli Infection of Developing Hydronephroses.—There are several clinical and anatomical facts that point to the bowel as a possible source for *B. coli* which are so commonly found in urinary tract infections. *B. coli* have been isolated from the blood during the process of infectious diarrhoea. Pyelitis in children has been noted most frequently

INFECTION OF PERMANENT HYDRONEPHROSIS

with the incidence of summer diarrhoea. Several authors have mentioned the occurrence of constipation in pyelitis cases.

Anatomically, Franke³ has described lymphatics connecting the bowel and right kidney and though he demonstrated these fine lymphatic connections in but 20 per cent. of the bodies examined, the theory of passage of organisms from the bowel to the right kidney has been rather firmly established in urological literature. In reading Franke's articles on this subject, and in studying his drawings of injected lymphatics between the cæcum and the right kidney capsule, the possibility of infection of the kidney by continuity from a diseased appendix or inflamed bowel adherent to the peritoneum over the kidney, is obvious. It is questionable, however, how possible it is for infection to

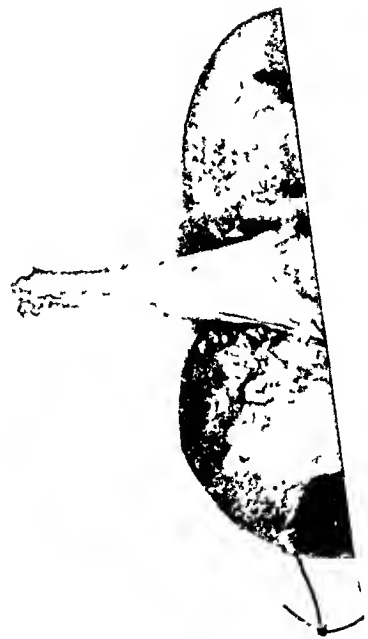
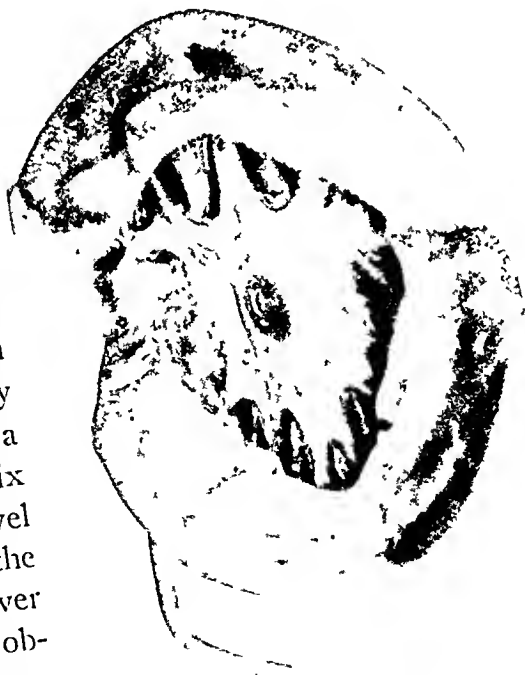


FIG. 4.—Dog 33. Six-day hydronephrosis after ligation of ureter and control kidney.

travel by the lymphatics from the bowel to the kidney if there be no gross lesion of the bowel or inflammatory process in the bowel which would cause adherence of the bowel to the kidney capsule. It is questionable because the lymphatic vessels between the bowel and kidney capsule are very small, relatively few in number, and inconstant. The lymph flow from the intestine and

appendix is to the mesenteric glands and not toward the kidney. Lastly, it is not definitely known that organisms leave the normal or slightly damaged bowel to gain access to the lymphatics other than the mesenteric glands. The presence of organisms in the mesenteric glands is by no means synonymous with kidney infection or blood stream infection.

The striking work of Ravenel,⁴ Calmette,⁵ and Griffith,⁶ on the passage of tubercle bacilli and pigment through the normal bowel mucosa makes it

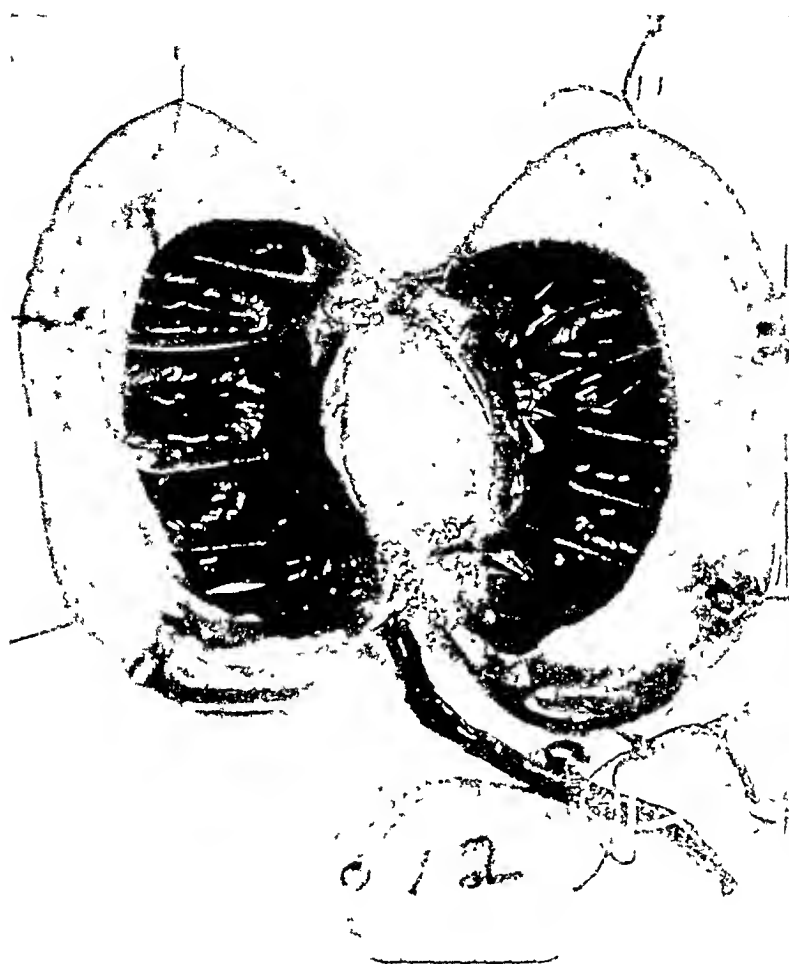


FIG 5.—Dog 12. Eleven-day hydronephrosis after ligation of ureter.

the colon bacillus through the normal and pathological bowel wall to the mesenteric glands, to the blood stream, or directly into the urinary tract through the lymphatics. A hydronephrosis was established on the right side by ligation of the ureter, to serve as a filter for any organisms reaching the urinary tract on that side. Controls were studied and experiments conducted to ascertain the effect of introduction of large amounts of actively growing *B. coli* into the intestinal tract of dogs during fat digestion, during periods of marked constipation or prolonged diarrhoea, and after obstruction or traumatism of the bowel.

Injection of *B. coli* into the mesenteric glands, and transplantation of

seem very probable by analogy that other bacteria might penetrate the normal mucosa of the bowel. Thiele and Emberton,⁷ von Picker,⁸ and others have reported experiments which seem to favor the point, while Opitz,⁹ and Neisser,¹⁰ in carefully conducted work throw great doubt upon it.

Author's Experiments on Dogs.—Experiments were conducted on thirty-seven dogs to study the possibility of the passage of bacteria, especially

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impregnated *B. coli* gauze into the mesenteric glands was carried out to attempt infection of the hydronephrosis *via* the lymphatics.

In obtaining material for culture at post-mortem, the abdomen was opened with sterile surgical technic. Bladder urine, right hydronephrotic urine and left kidney urine were taken for culture. Tissue culture of the mesenteric glands, kidney parenchyma and liver parenchyma were made by putting the tissue through a sterile Rosenow grinder and using the tissue emulsion in

ascites bouillon and ascites blood for culture. Hearts blood was used for culture. Culture of the urine by aspiration from bladder was obtained by exploratory laparotomy in practically all experiments and all dogs with organisms in their urinary stream were excluded.

As the details of the experiments have been published elsewhere, only the conclusions derived from them will be given.¹

(1) In control dogs with normal intestines, the mesenteric glands contain bacteria in over 50 per cent. and contain *B. coli* in 33 per cent. of the glands examined. These facts speak conclusively for the passage of organisms from the normal bowel to the mesenteric glands.

(2) Injection of large amounts of actively growing *B. coli* into the normal gastro-intestinal tract of dogs was associated with the presence of *B. coli* or a *B. coli*-like organism in the urinary tract of three of eleven dogs. It is probable that these organisms reached the urinary tract by way of the blood

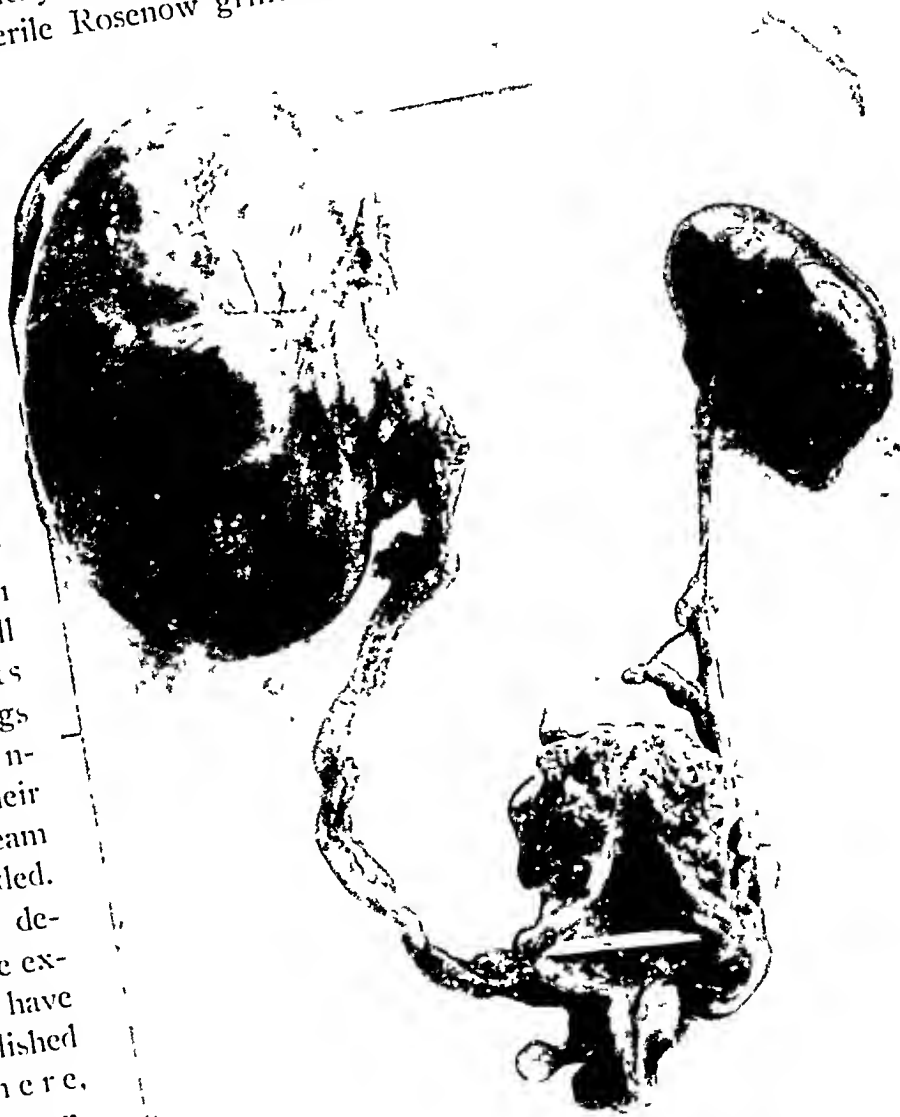


FIG. 6.—Dop DD. Two weeks hydronephrosis after ligation of ureter.

stream. The lowered resistance of these animals afflicted with distemper seemed to predispose them to infection of the urinary tract.

(3) Moderately prolonged constipation and diarrhoea in dogs was not associated with relative increase of organisms in the mesenteric glands or with

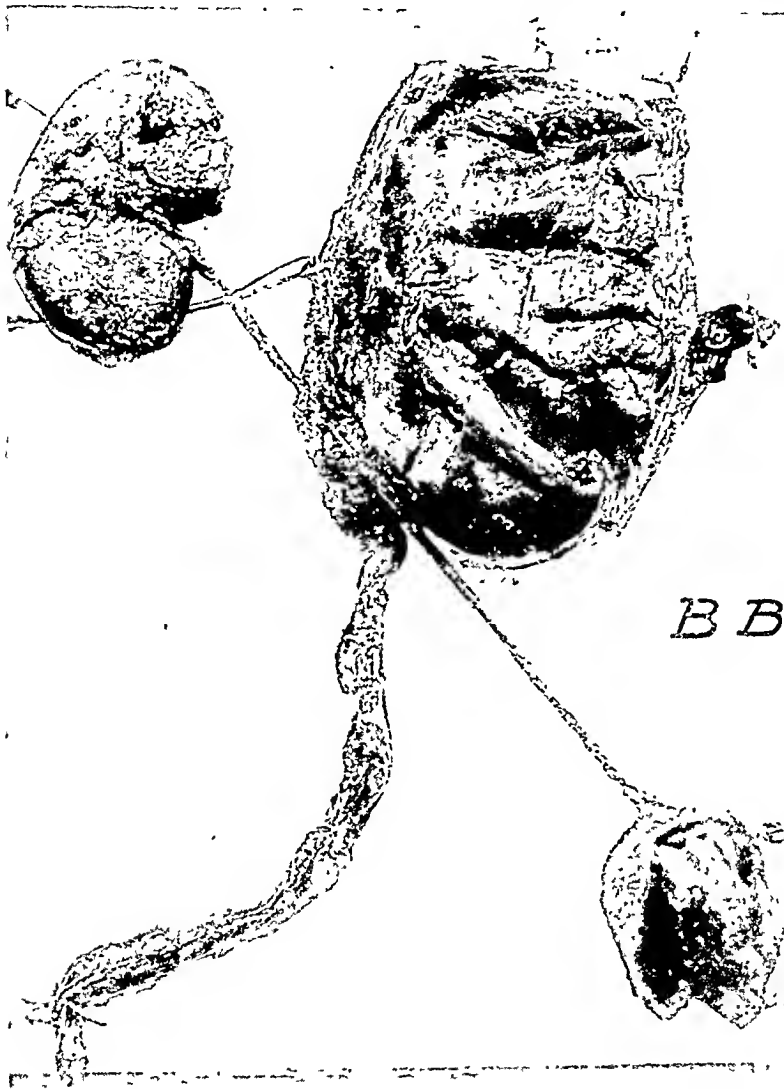


FIG. 7.—Dog BB. Thirty-eight-day hydronephrosis from ligated ureter. Death from respiratory disease. Sterile hydronephrosis.

a urinary tract infection.

(4) Obstruction of the large bowel, or traumatism of the bowel is associated with an increased bacterial content of the mesenteric glands and urinary tract infection occurred in two dogs.

(5) No evidence was forthcoming that organisms reaching the mesenteric glands from the bowel tended to involve the urinary stream by way of the lymphatics. It is probable that Franke's hypothesis in this connection would apply

only to those instances where a diseased bowel or appendix was in contact with the peritoneum overlying the kidney. This explanation obviously would not include the great majority of kidney infections.

(6) Cultures of live tissue, bile, and hearts blood were uniformly sterile and led one to believe that organisms leaving the normal intestine do so in small numbers and are at the most but transient inhabitants of the blood or liver tissue.

(7) The significance of the passage of intestinal organisms through normal as well as pathological bowel wall to the mesenteric glands cannot be

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overlooked. While it is undoubtedly true that these organisms reach the blood stream in but relatively small numbers and inconstantly, it is, nevertheless, possible that increased virulence of the organisms, lowered resistance of the host as

well as actual lesions of the bowel wall would greatly increase the number of organisms reaching the blood stream. This conclusion would accord with the clinical relation between gastrointestinal lesions and urinary tract infections.

It is possible, therefore, that a developing hydronephrosis in man may be infected from organisms reaching the blood stream from the bowel.

Blood Stream Infection of Hydronephrosis.—

From the foregoing material it becomes apparent that

blood stream infections, from whatever source, are the most common means of entry of organisms into a developing hydronephrosis. Many years ago Beidle and Kiaus¹² and Brewer¹ demonstrated that organisms



FIG. 8.—Dog EE. Four and one-half-month hydronephrosis from ligated ureter. Intravenous injection of *B. coli* three months and four months after ligation of ureter did not inject the hydronephrosis.

were rapidly secreted into the kidney urine, after their introduction into the blood stream. To convince ourselves that *B. coli* were thus easily secreted into the kidney urine after injection into the blood stream, two dogs were used. The right ureter was divided and a fine canula placed into its proximal end. Cultures of the right kidney and bladder urine were



FIG 9—Dog GG. Seventeen months sterile hydronephrosis from ligation of ureter. Intravenous injection of *B. coli* nine months after ligation did not infect the hydronephrosis.

taken for control. Two cubic centimetres of a *B. coli* suspension in salt solution were injected into the femoral vein, and cultures were taken every few minutes from the right divided ureter as well as from the bladder urine. After one minute, 4 to 6 drops of right kidney urine grew 17 to 20 colonies of *B. coli*. A decreasing number of colonies were present from the right kidney urine at intervals of 4 to 35 minutes after the intravenous injection of *B. coli*. After 35 minutes only one colony was grown. This shows that *B. coli* in the circulating blood are very rapidly secreted

into the kidney urine and that after 35 minutes have practically disappeared from the kidney urine. This is of special interest in establishment of infectious lesions in the urinary tract because without obstruction of the urinary outflow it is probable that the organisms are very rapidly eliminated in the urine and produce no lesions.

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The effect of ligation of the ureter and development of a hydronephrosis on the kidney function has been carefully studied experimentally by Bradford,¹⁴ Keith and Snowden,¹⁵ Keith,¹⁶ Johnson,¹⁷ and others.

While the kidney still has some power of secretion at the end of two months, death results if urinary secretion is left entirely to a kidney which has been obstructed for only 19 days (Johnson). Hinman¹⁸ found a kidney obstructed for 26 days did not regain any of its function. With these facts in mind a series of experiments were conducted in 10 dogs to ascertain whether it was possible to infect a hydronephrosis due to complete obstruction of the ureter. In dogs having sterile urine at the time of ligation of the ureter, intravenous injection of 2 c.c. of actively growing *B. coli* was carried out at intervals varying from one day to nine months after ligation of the ureter. It was found that infection of a hydronephrosis of 1 day, 2 days, 15 days, 20 days, and 60 days' standing was uniformly accomplished by intravenous injection of *B. coli*.

In contrast to these results were the failures to infect hydronephroses of 3 months, 3½ months, 4½ months, 5 months, and 9 months' duration by

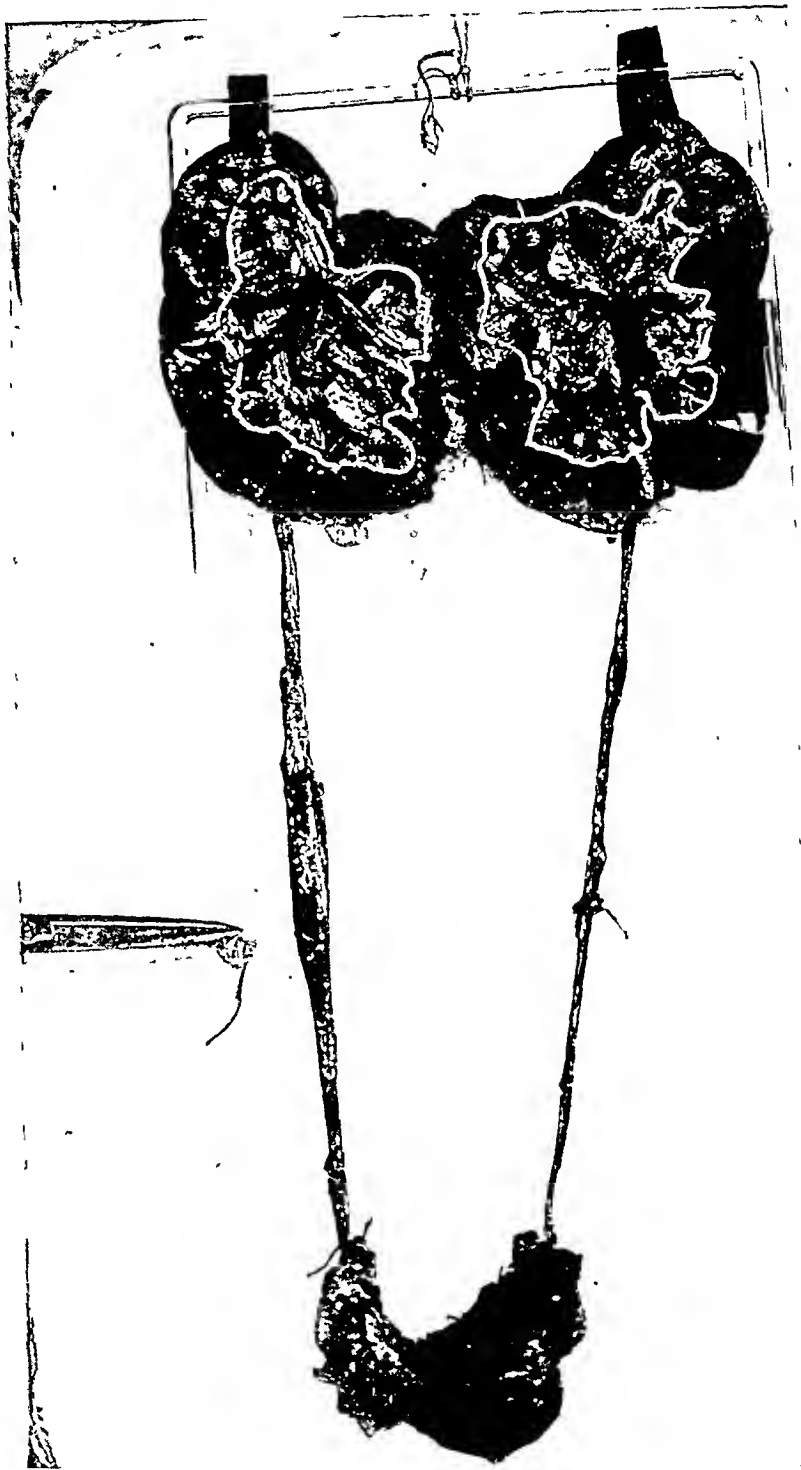


FIG. 10.—Patient died six days after bilateral ligation of the ureters during an operation for carcinoma of the uterus. At post-mortem, both ureters were enormously distended. The right ureter measured 1.25 cm. in diameter and the left ureter 1 cm. in diameter. The walls of the ureter were thin, as though the dilatation had been acute. The renal pelves were markedly dilated and the urine contained in them was under high pressure. Pelvis of kidney outlined.

intravenous injection of *B. coli*. From these experiments it seems justifiable to conclude that at some time between two and three months after ligation and division of a ureter the resulting hydronephrosis cannot be infected by the way of the blood stream. If by inference these results may

be applied to the human, it is obvious that the real danger of infection of complete hydronephrosis is in the first three months of its development.

The accompanying illustrations indicate the degree of atrophy of the kidney parenchyma as well as the dilation of the kidney pelvis following ligation of the ureter in the dog. The intrapelvic pressure taken in several of the hydronephroses of over three months' duration gave about 1.5 cm.



FIG 11 —Patient died after prolonged labor. Autopsy revealed a bilateral hydronephrosis.

pressure of mercury. The fluid in the hydronephritic sac was straw colored and slightly cloudy and the data on p. 531 was obtained from examination of the 18 months hydronephrotic fluid.

Compared to the figures for these substances in normal dog urine they are present in very much less quantities, but nevertheless show many of the constituents characteristic of urine.

INFECTION OF PERMANENT HYDRONEPHROSIS

Appearance	Cloudy
Color	Light amber
Specific gravity	1011
Reaction	Acid
Serum	Albumen (plus, plus)
Casts.	0
Cells-blood	0
Leucocytes	Few
Benzidin test for blood	0
Crystalline elements	0
Sugar	Very slight reduction
Urea	Very little in comparison to urine
Uric acid	2.20 mg. per 100 c.c.
Creatinine	14 mg. per 100 c.c.
Total nitrogen	164 mg. per 100 c.c.
Non-protein nitrogen	104 mg. per 100 c.c.

CONCLUSIONS

(1) Closed hydronephroses in dogs may be infected through the blood stream up to three months after the onset of their development.

(2) Closed hydronephroses of more than three months' standing are no longer liable to infect through the blood stream.

(3) Closed hydronephroses are rarely, if ever, infected through the lymphatics leading from the bowel to the kidney. Ascending ureteral lymphatic infection of hydronephroses is possible but improbable.

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THE FATE OF THE FRACTURED CARPAL NAVICULAR*

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THE position of the navicular bone in the carpus is probably one cause of its injury in falls on the hand or similar traumata, such as backfire jerks when cranking an automobile engine. Although the bone lies in and dominates the proximal row of the carpus, its position changes over a wider arc in all wrist movements than any other carpal bone. This bone attempts also to ally itself with the distal row. If falls are sustained on a hand in true adduction, the navicular bears much of the brunt of the forced extension of the wrist and the conveyance of force to the forearm. Navicular fracture with or without dislocation of one or both fragments is a fairly frequent occurrence.

The blood supply of all the carpal bones is rather scant, arising from terminal branches of the radial and ulnar arteries, which spread out in a periosteal branching without the formation of a true nutrient artery. Some blood reaches the bone *via* the ligamentous attachments. The navicular receives its supply from small vessels which enter about the middle of the bone and spread out as indicated in the periosteum to supply both the cartilage and osseous tissue. As the usual site of fracture of this bone is near its middle, because of its peculiar anatomical position, the blood supply is always seriously interfered with immediately inasmuch as these small vessels are torn off by the trauma. Even the ligamentous supply can be cut off by lacerations.

Men sustaining carpal injuries may not present gross deformities, crepitus, or much immediate change in function, so that a large proportion of the fractures are overlooked clinically. It is also true that even when a skiagram is made of the wrist a fracture may not be noticed. There results consequently non-recognition of the fracture of the navicular; advice is given to use the wrist. Baking, forced passive movements and active movements are insisted upon and no fracture diagnosis is made until weeks, months or years later, when the dysfunction becomes so prominent that someone interprets the condition correctly from the symptoms and a skiagram. In some patients not only is the navicular fractured, but one of the fragments, usually the proximal, is dislocated out of position in relation to the radius and the surrounding carpal bones. This fragment dislocation may be accompanied by its companion in the proximal carpal row, the lunate. It is not my purpose to go into the symptomatology, but to attempt a description of the fate of the bone.

The course of the life of the navicular after a fracture may take either of two different paths. Fracture without separation (dislocation) of fragment or with impaction, which is recognized and treated by early and prolonged

* Read before the American Surgical Association, April 18, 1924.

THE FATE OF THE FRACTURED CARPAL NAVICULAR.

immobilization, may heal satisfactorily without untoward results. This fact has been shown clinically.

The fracture unrecognized or discovered after a time of a week or more, during which motion and use have been advised, pursues a different course. It is with this quite common result that we must deal. After the unrecognized and misused fracture, pain increases for a period of several years. Along with the pain comes diminution of functional use of wrist, hand and forearm, betrayed by lack of hand grip, decreased wrist motions and atrophy of the forearm muscles.

In the navicular bone after complete fracture, excepting isolated fractures of the tuberosity, blood supply is rapidly cut off and the main mass of the bone cells undergoes slow death. Just how long it takes for this death to occur cannot be positively stated; probably it is complete within a week. The navicular then at first retains its original density, and as the weeks and months pass, when pain inhibits use of the other bones of the hand and forearm there is seen a marked contrast between the navicular and neighboring bones, which must lose calcium in the process of atrophy of disuse. This atrophy can be demonstrated even in the forearm bones. Formation of a new blood supply is constantly discouraged by movements of use which overcome the delicate efforts of the small vessels involved. As attempts at use or passive movements are continued, the loss of blood supply of the bone becomes permanent.

A few weeks after injury a skiagram shows the plane of fracture, a navicular uniformly dense and with deeper shadow than the other carpal bones. As time passes, the plane of fracture appears to widen and less difficulty is experienced in making a röntgenologic diagnosis. Eventually the bone appears to undergo absorption in its body. The cartilaginous and cortical edges retain their outline markings for many months, but in three to five years light spots appear in the bone shadow quite remote from and not necessarily connected with the apparent bone absorption going on at the fracture plane. These lighter areas may be puzzling unless one studies the pathology minutely. New bone formation from surrounding bones begins to appear in one to two years, and if an average of five years is taken we may expect to find considerable exostosis formation manifested from the lower articular end of the radius. The degree of this new bone development is probably governed by the amount of forced work attempted by the injured hand. In women who do little manual labor the exostoses are minimal; in adult men the amount of bone thrown out may cloud the lines of the wrist and carpus and appear to be sufficient to cause bony ankylosis.

At operation on the fractured navicular three to five years after the break, when the carpal joint is opened synovial fluid is present. This is not abnormal except that it may be slightly thicker and stained a deeper yellow color than normal. The bone when exposed to view seems eroded, its surface may present pits and the cartilage may be wanting, especially near the fracture plane. On the whole, however, the cartilage retains its color, apparently is

living, and may have its normal smooth or shiny surface. When an attempt is made to remove the bone fragments, they are found to be quite friable and if care is taken to remove them *en masse*, one finds that the bone has become a mere shell of surrounding cartilage and cortex which encloses a yellow fat-like material. This internal portion of the bone is all that remains of the former rather dense cancellous tissue of the body of the navicular. It may easily be scraped and lifted out from the enclosing shell. There is erosion and absorption of bone grossly evident at the plane of fracture, and although only two fragments could be made out in the skiagram, three or more may be found in the specimen. Overlying shreds of old capsular ligament may be adherent to the bone, especially at the tubercle. As a rule the joint capsule has completely healed and is represented by an abnormally thick whitish fibrous material.

Specimens of the untreated fractured navicular removed within six months after the time of injury, show on microscopic examination that the main mass of the cancellous bone tissue is dead. No normally staining nuclei can be found in the bone cells. At the fracture surface two general changes can be noted, one regenerative, the other degenerative. There is a very faint effort at new bone or callus formation. This is really only in microscopic areas. The main change is degenerative. The mass of cancellous tissue near the fracture plane has lost its cellular identity. Extending from the fracture surface is an invasion of small round cells in which are scattered many of the osteoclastic giant multinuclear cells marking a steady progressive absorption of the bone. The cortex and cartilaginous rim usually present a better resistance and around the edges of the bone the section shows cells and nuclei with practically normal staining reaction, evidently still alive. The main mass of the cancellous tissue, however, is dead.

After four or five years the whole interior of the bone is soft and fat-like. On section of this material nothing is found but fibrous tissue, no fat, no trace of bone cells or lamellæ. Around the bone edge the shell is composed of cortical bone with a few rows of bone cells containing nuclei and with fairly healthful cartilage covering where it should be present.

After a study of a series of these fractures at varying periods after the original trauma, I feel justified in saying that the original fracture interference with the blood supply cuts off nutrition to the cancellous structure. Should the condition be recognized and sufficient rest be offered the bone, revascularization with a saving of the bone may result. In the neglected cases bone death rapidly ensues, and the process of malacia or osteoporosis begins, ending in complete absorption of the main mass of the bone. As far as I can determine we must revise our ideas about the influence of the synovial fluid on these fractures. It has formerly been taught that the irritative effect of the synovial fluid led to destruction of the bone, but my sections seem to prove just the opposite, namely that the synovial fluid offers sustenance to the superficial layer of cartilage and cortical bone and maintains the nutrition of the cells for years.

THE FATE OF THE FRACTURED CARPAL NAVICULAR

The new bone formation from surrounding bones must be a reaction to the presence of the dead navicular and is protective, that is, it is a natural effort to stiffen the wrist to inhibit motion and consequently relieve the patient from pain.

Using the clinical and pathologic evidence obtained from a series of these injuries, there is no hesitation in advising immediate and prolonged splinting of the fractured and undislocated navicular. If dislocation of the fragment has occurred, I believe operative removal is indicated. Certainly in all fractures unrecognized more than a few days operative removal of the whole bone promises the quickest return of function in the hand and wrist. Delay gains nothing.

THE REGENERATION OF THE MENINGES

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THE PIA-ARACHNOID

IN A previous paper ¹ evidence was presented to show that the dura mater when injured heals rapidly without the formation of adhesions to the subjacent structures. The mechanism of the repair of this membrane is similar to the repair of an injury elsewhere in the body with the exception that the external surface of the arachnoid acts as a limiting membrane beyond which no further reaction takes place and against which the inner lining of the dura is formed. This impregnability of the arachnoid surface to the reaction of repair in the dura prevents the formation of adhesions and acts as a mould for the reconstruction of the dura. Reason was found for suspecting that the cells on the inner surface of the newly formed dura are derived from the polyblasts or fibroblasts of the organizing blood clot, rather than intact dura.

In view of these findings it seemed of interest to investigate the healing of the pia-arachnoid when the site of its injury was covered by normal dura. It was supposed that under these circumstances a similar reaction would take place and that the pia would heal also without adhesions.

Healthy adult dogs were chosen as the subjects of these experiments and the operative procedures carried out with complete surgical asepsis under ether anæsthesia. The skull was opened in the parietal region with a crown trephine and the defect enlarged with the rongeur to a size of about 8 square cm. which was roughly rectangular in shape. A curved dural flap with the convexity upward was turned down, great care being taken not to injure the pia and to protect the inner surface of the dura from any damage. In the first series of these experiments the pia over the cortex, well away from the line of dural incision, was touched with the tip of a spatula which had been brought to a cherry red degree of heat. This immediately produced a coagulation of the pia-arachnoid together with a thin layer of the adjacent cortex. The dural flap was then replaced and carefully sutured with interrupted fine silk sutures. The wound was closed in layers with interrupted silk sutures, care being taken to obtain accurate approximation. In a second series of experiments the same procedure was employed with the exception that the injury to the pia was obtained by plunging the point of a mosquito clamp through it into the cortex and spreading the points apart on with-

THE REGENERATION OF THE MENINGES

drawal, thus producing a small, sharply localized area of injury. The animals were sacrificed by ether at appointed intervals of time, the brain and meninges carefully examined in gross, following which suitable blocks of tissue were hardened in formalin for microscopic study.

The protocols are as follows:

Series I.—PROTOCOL I, Dog No. 12.—Operated upon January 8, 1923 and sacrificed on January 16th, 8 days duration.

Gross Examination.—The dural wound was healed per primam and there were no adhesions present along the line of suture. At the site of the pia-arachnoidal injury the dura was firmly adherent to the damaged pia-arachnoid and forcible stripping resulted in laceration of the underlying cortex.

Microscopic Examination.—Section was made through the area of adhesion noted above. The dural portion of the section shows fibroblastic activity on the outer aspect where the muscle is undergoing a process of healing in conjunction with the endosteal layers. The dura itself is somewhat swollen on its cortical aspect and there is an invasion of young fibroblasts among the fibrous strands composing the first two or three layers of the dura nearest to the injured pia. Beneath this the blood clot is being organized with a great deal of young fibroblastic tissue. This gradually becomes a clear layer of newly forming fibrous tissue overlying cortical debris which on the separation of the adhesions was stripped away. The cortical portion of the section shows nothing of importance except the granular broken down brain tissue to which is attached here and there a fragment of the new fibrous tissue.

PROTOCOL II, Dog No. 6.—Operated upon September 12, 1922 and sacrificed on October 3, 1922, 11 days duration.

Gross Description.—The dural wound was healed per primam. Upon attempting to separate the dura from the underlying cortex there were found adhesions at each point of suture between it and the pia-arachnoid, but there were none in the spaces between the sutures. The dura was very tightly adherent to the damaged pia-arachnoid but peeled away fairly readily leaving a slightly discolored velvety area at the centre of the zone of brain injury.

Microscopic Examination.—The cortex is broken down and shows on its meningeal surface an active healing process which includes some new vessels with fairly well developed walls. Round cells and polyblasts in various stages of activity prevail through-

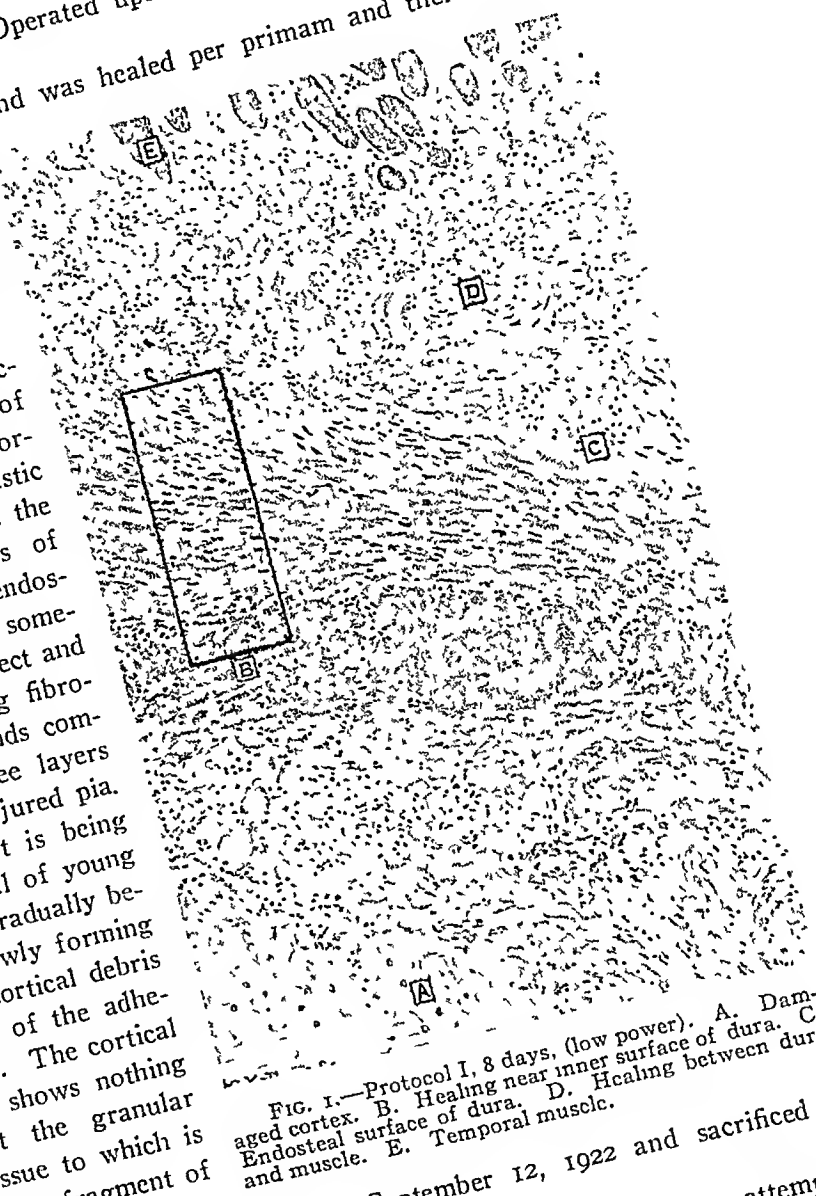


FIG. 1.—Protocol I, 8 days, (low power). A. Damaged cortex. B. Healing near inner surface of dura. C. Endosteal surface of dura. D. Healing between dura and muscle. E. Temporal muscle.

out the field with here and there a large flat cell with a single nucleus. The large cells are found throughout the regenerating area and are undoubtedly macrophages.

PROTOCOL III, Dog No. 5.—Operated upon September 20, 1922 and sacrificed on October 4, 1922, duration 14 days.

Gross Description.—The dural wound had healed per primam. Adhesions were present at two suture points but the remaining seven suture points were not adherent to the subjacent pia. The dura stripped away readily from the underlying structures but carried with it a fine granular surface intimately connected with the underlying brain. The cortical surface was somewhat rough and had a velvety appearance but showed no distinct gross injury.

Microscopic Examination.—The section through the area mentioned above included the dura and the healing area of the damaged pia-arachnoid and cortex. The dural portion shows normal, intact dura but arising from it on the pial aspect there are numerous fibroblasts and some more mature fibrous connective tissue. On the cortical side there is a definite polyblastic activity with a deep layer of fibrous tissue. The entire healing process involves the dura, pia and arachnoid and merges them all into one compact layer which, on separation in gross, was pulled away from the cortex, carrying some of it with the dural portion.

PROTOCOL IV, Dog No. 4.—Operated upon September 26, 1922, and sacrificed on October 12, 1922, duration 16 days.

Gross Description.—The dural wound had healed per primam. There was an adhesion at one suture point but the remainder of the sutures were free from the pia-arachnoidal surface. The dural surface when peeled away from the cortex was smooth except at the site of the cortical injury where a granular mass was adherent to the dura. The brain surface seemed clean and was not definitely lacerated but had a somewhat velvety appearance. There was no evidence of gross adhesions between the dura and the pia.

Microscopic Examination.—This section, like the preceding one, shows a well formed compact dura. The portion of the membrane directly overlying the damaged cortex is adherent to the healing process beneath it. The form of the adhesion is that of a continuity of structure of the normal dura and the fibrous tissue which is being laid down over the damaged cortex to replace the injured pia-arachnoid. As in the preceding section there is no point of difference between the dura, pia and arachnoid, the whole forming one homogeneous layer of fibrous tissue which has peeled away from the subjacent cortex, carrying a portion of it along.

PROTOCOL V, Dog No. 3.—Operated upon September 15, 1922 and sacrificed on October 3, 1922, duration 18 days.

Gross Examination—The dural wound had healed very well, with one point of suture adherent to the cortex, the others being free. In the centre of the dural flap and overlying

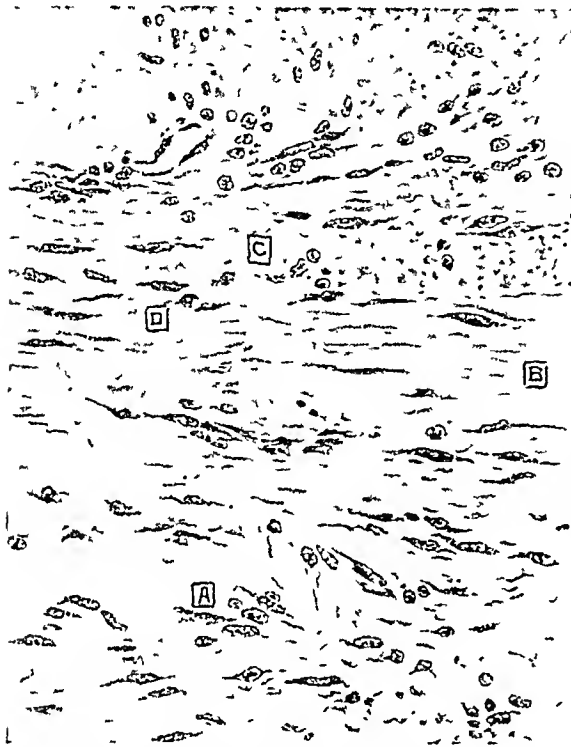


FIG. 1a.—Protocol I, 8 days, (high power). A. Endosteal layer of dura. B. Undamaged dura. C. Healing of damaged area below normal dura, showing invasion of dura by the healing process at D.

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the site of the pia-arachnoidal injury there was a dark brown mass about 1 x 1 cm. which on section appeared to be covered by a fine glistening layer of tissue continuous with the inner surface of the dura. There was a depression on the cortex underlying this mass corresponding in area and in position to the mass on the dura. The cortex itself was velvety in appearance.

Microscopic Examination.—The dural portion of the specimen shows an interesting and important condition. The mass described in the gross examination appears to be covered by a definite limiting membrane. Continuous with the dura and beneath it is a blood clot undergoing progressive fibrosis. The layer which is described above as lying beneath the clot is also composed of fibrous connective tissue and resembles the adjacent dura, joining with it at either side of the mass. The cortex is broken down and filled with residual blood pigment and cortical debris. There is some early fibrosis. The blood-vessels show well-defined walls. There is little evidence of any pia-arachnoid tissue on the cortical portion of the section, the regenerating membrane having been stripped away with the dura.

PROTOCOL VI, Dog No. 7.—Operated upon October 24, 1922 and sacrificed on November 14, 1922, duration 21 days.

Gross Examination.—The dura separated readily from the cortex and was glistening in appearance except at the area overlying the cortical damage where a portion of the cortex was adherent to the dura. The injured cortical surface had the same velvety appearance as noted previously.

Microscopic Examination.—The muscle and the dura are practically normal in appearance. The dura is fibrous and shows on its inner aspect numerous young fibroblasts, an occasional red cell and rarely a macrophagic cell as described in previous examinations. The cortical surface is irregular and not covered by anything resembling pia-arachnoid, the healed membrane having stripped away with the dura and forming a portion of it.

PROTOCOL VII, Dog No. 8.—Operated upon November 10, 1922 and sacrificed on December 8, 1922, duration 28 days.

Gross Examination.—The dura was well healed along the line of suture and showed no adhesions at any suture point. There was no gross evidence of adhesions between the dura and the cortex. The damaged area of the brain had a velvety appearance and was overlaid by one fairly large vessel. There was no gross evidence of cortical substance adhering to the dura.

Microscopic Examination.—This section shows a condition similar to that in the

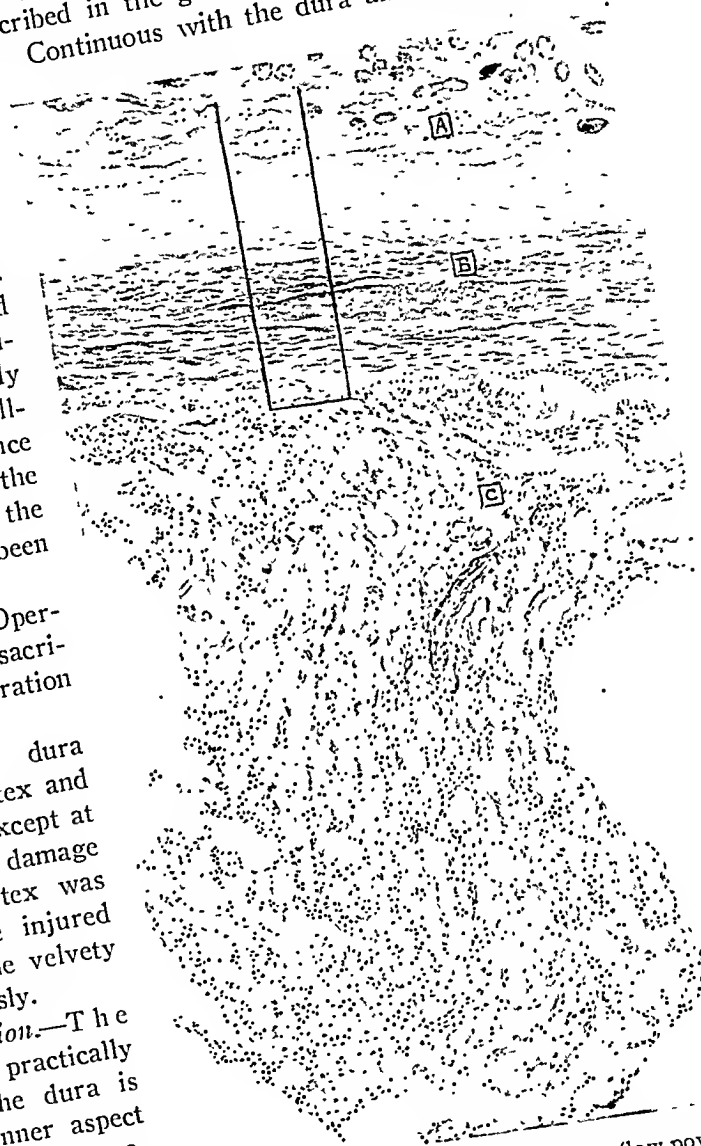


FIG. 2.—Protocol IV, sixteen days, (low power). A. Temporal muscle. B. Dura adherent to damaged cortex. C. Cortex.

previous examination, but more advanced. What seemed to have been dura stripping away from the cortex is actually one layer of tissue including normal dura which is lined by a thin membrane of young fibrous tissue of varying thickness resembling the arachnoid and below this layer some of the cortex. The process of the healing of the cortex, pia-arachnoid and dura into one cicatrix is complete.

PROTOCOL VIII, Dog No. 10.—Operated upon on January 8, 1923 and sacrificed February 15, 1923, duration 38 days.

Gross Description.—The dura easily stripped from the underlying structures but was covered with a brownish mass of tissue which was recently organized blood clot.

Sutures were everywhere healed over on the inner surface of the dura and were covered in by glistening membrane. The cortex showed a general ecchymosis and was swollen and granular in appearance. The general picture was that of the healing of a recent injury rather than of one produced at the time of the operation.

Microscopic Examination.—The dura shows a thick layer of fibrous tissue which on its cortical aspects gives evidence of a recent healing process with free blood cells, round cells and fine granulation tissue. The picture is probably due to a fairly recent trauma. On the cortical surface the brain is free of pia-arachnoid except where the membrane was undamaged or out of the experimental field. One portion of the dural section shows the dura joined to adjacent granulation tissue and some broken down cortical substance. This portion corresponds to the defect in the brain caused by stripping the dura away from it.

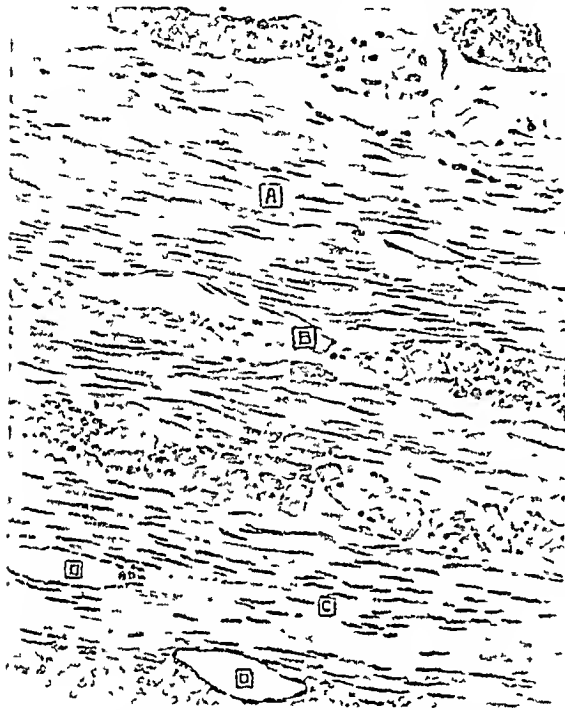


FIG. 3.—Protocol IV, sixteen days, (high power). A. Normal dura covering site of injured pia-arachnoid. B. Point of continuity of healing between dura and new pia. C. Layer of fibrous tissue which has replaced damaged pia-arachnoid. D and D'. New blood-vessels lying beneath layer C.

Series II.—PROTOCOL I, Dog No. 260.—Operated upon July 20th, sacrificed on August 28th, duration 39 days.

Procedure.—Decompression left side, dural flap turned down and then stitched back into position. No damage done to pia-arachnoid.

Gross Examination.—No adhesions. The dura was everywhere completely healed. Sutures show plainly through the lining of the dura and at one point where the edges have retracted new dura had been formed completely filling in the defect.

Microscopic Examination.—The pia-arachnoid underlying this area shows no evidence of damage, and no adhesions.

PROTOCOL II, Dog No. 2114.—Operated upon July 19, 1923 and sacrificed August 28th, duration 40 days.

Procedure.—Large decompression flap turned down and the dura reflected downward without any injury to the pia. At the lower edge of the area exposed beneath normal dura a mosquito clamp was struck through into the brain and spread so as to cause a defect in the pia-arachnoid. The dura was sutured back into position with interrupted silk. A small amount of blood clot was left beneath the dura.

Gross Examination.—Adherent only at the point of puncture. Here on separation

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small fragments of cortex were torn out and came away with the dura. Healing has taken place in the region of the stitches without adhesions.

Microscopic Examination.—There is a scar in the cortex completely healed where the mosquito clamp entered. At the surface in this region the pia-arachnoid has disappeared and the dura is apparently directly continuous with the scar.

PROTOCOL III, Dog No. 6.—Operated upon July 25, 1923 and sacrificed August 28, 1923 duration 34 days.

Procedure.—The same procedure was carried out as in the previous experiment with the exception that the dura was not stitched into position but simply laid back over the defect in the pia-arachnoid.

Gross Examination.—The dura is retracted about $\frac{1}{2}$ cm. but this area is healed over with only a few very fine and cobwebby delicate adhesions. The site of the injury was completely covered by what had been normal dura. On pulling it away from the cortex, however, it brings with it cortical tissue, leaving a defect at the point where the original injury was made.

Microscopic Examination.—Not made.

PROTOCOL IV, Dog No. 3120.—Operated upon July 26, 1923 and sacrificed August 25th, duration 30 days.

Exactly the same procedure was carried out as in the previous experiment.

Gross Examination.—On separation of the dura from the cortex there are two dense adhesions, one at the upper angle of the dural flap at a point where the pia came in contact with an uncovered bone spicula and undoubtedly was injured. The second adhesion was to the dura at the point where the clamp had penetrated. Elsewhere the retracted dura had healed without adhesions.

Microscopic Examination.—Not made.

DISCUSSION

As a result of these experiments it has been found that where there is an injury to the pia-arachnoid and cortex, even though the overlying dura is uninjured, dense adhesions between all three layers of the meninges and the cortex are formed. As early as eight days following the injury, the dura is sufficiently adherent to tear away with it portions of the underlying cortex. The longer the period of healing, the greater the density of the adhesions and even after five weeks there is no attempt at solution of the adhesions and may feel certain then that injuries to the pia-arachnoid and underlying cortex lead to the formation of adhesions with the overlying normal dura, and that these adhesions persist.

Microscopically, at seven days post-operative, the dura is swollen and shows an invasion of fibroblastic and polyblastic cells which are passing inward toward the area of damage to the pia-arachnoid and cortex, where they meet similar elements engaged in the repair of these structures. In other words, the resolution of the injury takes place not only in the damaged membranes, but also in the overlying undamaged dura. As time goes on, the dura and the area of injury become organized into one fibrous structure, thus resulting in a firm adhesion of a strength sufficient to tear the underlying cortex on attempts at forcible separation.

One cannot help but suspect that in some fashion the dura involved has received some unrecognized injury and particular care was taken in the second series to avoid any possibility of this. The dura was opened and the

surface which was to lie over the injured point in the arachnoid was not touched even with saline and the damage to the pia-arachnoid and cortex was made by thrusting in a clamp and spreading the jaws on withdrawing it. It is certain then that the area of dura reacting to the pia-arachnoid injury was not in any extent itself damaged.

The second possibility that suggested itself was that the presence of blood alone might induce a reaction on the part of the dura. An experiment was tried in which the pia was not injured, but the dura opened and closed in exactly the same fashion as in the other experiments. A small amount of blood was left between it and the arachnoid but no adhesions resulted. This might have been expected from the fact that the dura will fill a defect in itself without forming adhesions to subjacent structures (by means of the resolution of the blood clot filling the defect). Whether or not the presence of blood induces any inflammatory reaction in the dura is not determined, and will be the subject of further investigation. In the presence of an intact arachnoid it does not produce adhesions.

It is known then, that a necessary premise to the formation of adhesions between the dura and the pia-arachnoid is injury to the latter. The injury in these experiments included damage not only to the pia-arachnoid, but to the cortex also. Might an injury thus extensive be necessary in order to obtain such a result? We think not, for in certain instances there were adhesions about the sutures placed in the dura. The injury here was undoubtedly caused only by the abrasion of the arachnoid by the suture itself, as extreme care was taken in the placing of it. Such an abrasion could scarcely do more than damage the lining cells of the arachnoid; certainly not the cortex, probably not the pia. It is felt then that the essential point in the formation of the adhesions found in these experiments is the injury to the outer cells of the arachnoid. In certain areas of the meninges where the arachnoid and pia are widely separated, as in the basilar cisternæ and over the cord, such injury would probably not involve the pia, which might well act then as another limiting membrane. However, over the cortex the septa are so numerous, and the lacunæ so shallow, that any reparative process in the arachnoid will probably stimulate a similar reaction in the pia, and if sufficiently severe, in the cortex itself. The essential factor is, then, the damage to the superficial layer of the arachnoid.

It is of interest to consider the reasons why the arachnoid and the dura react in such a different fashion when healing. It had been noted previously that the cells, which in the healing dura come to form the inner layer, are apparently derived from either polyblastic or fibroblastic cells originating in the adjacent tissue and not derived from an ingrowth of the cells lining the normal dura. They meet at the arachnoid surface an impenetrable barrier. On the contrary, the cells concerned in the organization of the injured arachnoid do not meet such a barrier on reaching the overlying dura, but pass directly into it, and the dura takes part in the inflammatory reaction. For two reasons then, the one that the lining cells of the newly constructed dura

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are probably derived from granulation tissue, the other that the lining cells of the normal dura do not prove impervious to the cells of the adjacent reparative action in the pia-arachnoid, it may be strongly suspected that the dura is not lined with true endothelium, but rather by cells which have undergone a certain metaplasia, from meso-blastic elements, in order to serve the same purpose.

Support for this opinion is derived from the experiments of W. C. Clarke,² who found that mesothelium could be formed from mesenchyme, even in adult life. Lewis³ states: "It seems probable that endothelium is a real differentiation from the primitive mesoderm, while mesothelium is more in the nature of a transformation in the form of the cells, due to environment." He has observed in tissue cultures the actual transformation of mesenchymal cells into the flat mesothelial forms. He interprets these observations, together with those of W. C. Clarke, as indicating that: "In the healing of wounds of the mesothelium lining the peritoneal, pleural and serous cavities, new mesothelium may arise from the subjacent mesenchyme by the change in form of its cells, and that the repair after abrasion of the mesothelium is not necessarily brought about by a spreading of the adjacent mesothelium over the wound, such as occurs in repair of skin wounds."

If transition so readily takes place in this direction, then one might well surmise that the reverse would occur with equal ease; that mesothelium might revert to mesenchymal cells under the stimulus of an inflammatory reaction. This probably takes place in the peritoneum, the pleura, and the pericardium, whose adjacent surfaces become adherent on the slightest provocation. That such adhesions do not take place when dura regenerates over the injured pia-arachnoid, is evidence that the latter is lined by a more highly differentiated form of cell. When the integrity of this is impaired, the dura mesothelium enters into the repair of the injury and the two membranes become adherent.

The clinical application of these findings is of interest, but largely speculatively so. It is understandable, that in order to have adhesions, there may not necessarily be any injury to the dura, or in other words, that damage to the lining cells of the pia-arachnoid will result in adhesions. It is apparent that this injury may be exceedingly slight and the frequent finding of adhesions at operation and at necropsy is therefore not surprising. Minimal birth injuries, mild attacks of encephalitis and of the so-called serous meningitis, and even the meningeal reactions that occur at the onset of many infectious diseases, may of themselves be sufficient to cause enough damage to the pia-arachnoid to lead to adhesions which later in life may be of clinical importance.

SUMMARY

The lining cells of the pia-arachnoid are more highly differentiated than those of the dura and therefore are more stable in character. The lining cells of the dura are mesothelium derived from the mesenchyme, are less stable and readily enter into any adjacent inflammatory reaction. When

destroyed they are replaced by the transposition of mesenchymal elements into mesothelium.

The inner surface of the dura does not act as a limiting membrane in the presence of an attempted repair in the underlying meninges, but on the contrary enters intimately into the process. Consequently the pia-arachnoid when injured becomes adherent to the dura, and heals with adhesions.

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THE TOXICITY AND RATE OF EXCRETION OF CALCIUM CHLORID FROM THE BLOOD STREAM

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DURING the last two years patients in the Mayo Clinic who had obstructive jaundice have been given pre-operative injections of 5 c.c. of a 10 per cent. calcium chlorid solution daily for three days prior to operation in order to lower a prolonged blood coagulation time, and thus diminish the possibility of post-operative hemorrhage. Such procedure has justified itself in the results on jaundiced patients, as reported by Judd and Lyons.

In the therapeutic use of any substance its toxicity is of prime importance, particularly when the medicament is to be given intravenously. In the surgical management of certain of the patients with obstructive jaundice the question has arisen of just how much calcium can be given safely intravenously, and over how long a period. This led us to undertake the study of the toxicity and excretion of calcium chlorid when injected intravenously in normal and jaundiced dogs. Joseph and Meltzer have found 444 mg. for each kilogram of body weight to be the lethal dose of calcium chlorid injected intravenously in a solution in which the crystalline salt is in molecular solution, so that 4 c.c. contain 0.444 gm. They injected this solution at the rate of 1 c.c. a minute. In general our results show a lower lethal dose than that reported by Joseph and Meltzer. Carrying out a technic of constant injection at the rate of 1 c.c. a minute of a 10 per cent. aqueous solution of calcium chlorid, we found the average lethal dose in normal dogs to be 256.4 mg. for each kilogram of body weight, and in jaundiced dogs 386.6 mg. for each kilogram of body weight (Fig. 1).

There is no doubt that the lethal dose of calcium-chlorid varies with the rate of its intravenous injection in both the normal and the jaundiced dog, and consequently its toxicity increases as the speed of the injection is increased. In one of our animals 154 mg. for each kilogram of body weight, when injected in five seconds, was sufficient to produce death. This again emphasizes the necessity of injecting solutions slowly intravenously. It is of interest that it required twice the amount of calcium chlorid intravenously to raise the blood serum calcium content* of the jaundiced dog to the same level as that of the normal dog, in spite of the fact that the blood calcium content is practically the same in the jaundiced and normal dogs before and after the

* We are indebted to Miss Helen Ross of the laboratory staff for the quantitative estimations of blood calcium in these experiments.

injection of a lethal dose; this suggests a calcium deficiency in the jaundiced animals which is not otherwise apparent.

The rate of excretion of calcium chlorid from the blood stream after its intravenous injection in various amounts in normal and jaundiced dogs, when

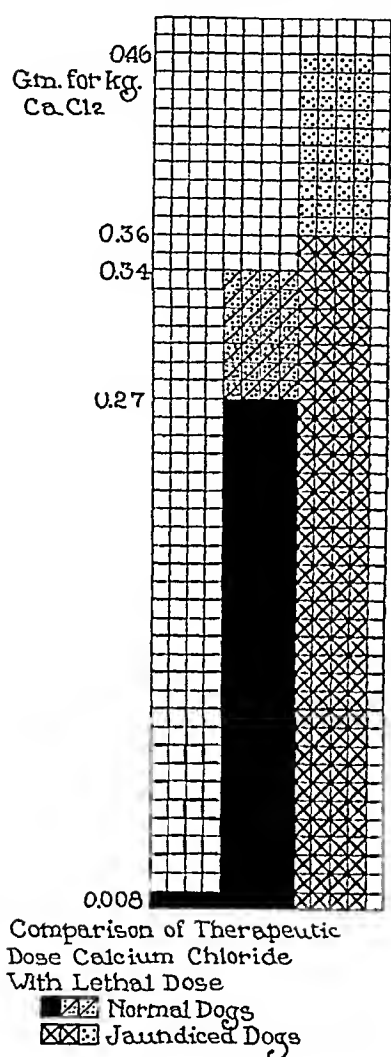


FIG. 1.—Comparison of therapeutic dose of calcium chlorid with lethal dose.

body weight, making a total of 0.88 c.c. of 10 per cent. solution.

May 8, 1923, 0.88 c.c. of a 10 per cent. solution of calcium chlorid was injected. Normal blood serum calcium was 8.0 mg. for each 100 c.c.; ten minutes after injection it was 9.2 mg.; thirty minutes after, 8.6 mg.; forty-five minutes after, 8.4 mg.; one hour after, 8.6 mg., and two hours after, 8.8 mg.

May 10, 1923, 0.88 c.c. of a 10 per cent. solution of calcium chlorid was injected. Normal blood serum calcium was 11.5 mg. for each 100 c.c.; ten minutes after injection it was 14 mg.; fifteen minutes after 13.3 mg.; thirty minutes after, 12.7 mg.; one hour after, 11.9 mg.; and two hours after, 11.3 mg.

Dog G261. Jaundiced.—May 2, 1923, under ether anaesthesia and employing sterile technic, a median line incision was made, and the common duct brought up and exposed

injected in 10 per cent. solution, is dependent on the amount of solution injected. Following small doses of calcium chlorid, such as the therapeutic dose (8.25 mg. for each kilogram of body weight) it was observed that elimination from the blood stream occurred in from one-half to one hour (Fig. 2). From five to six minutes after the injection, the blood serum calcium content in the normal unjaundiced dog was elevated from 1 to 2.5 mg. for each 100 c.c. After the same interval, the elevation in jaundiced dogs was from 0 to 1 mg. (Fig. 2). Following the injection of larger doses, such as ten times the therapeutic dose (82.5 mg. for each kilogram of body weight) complete elimination from the blood stream occurs within four hours. Five minutes after such an injection the blood serum calcium content in normal dogs is elevated 14 mg. for each 100 c.c. and in jaundiced dogs, 7.2 mg. (Fig. 3). The latter observation lends itself to conjecture concerning the ultimate fate of calcium injected into an animal with obstructive jaundice.

RATE OF EXCRETION OF A THERAPEUTIC DOSE OF CALCIUM CHLORID GIVEN INTRAVENOUSLY IN NORMAL AND IN JAUNDICED DOGS

Dog 2B. Normal.—Body weight 10.7 kg. The therapeutic dose was 8.25 mg. for each kilogram of

EXCRETION OF CALCIUM CHLORID FROM THE BLOOD STREAM

for a distance of 1 cm. The duct was ligated distally and proximally, and about 8 mm. of duct between the ligatures removed.

May 15, the dog was severely jaundiced. The body weight was 8 kg.; the therapeutic dose was 0.66 c.c. of 10 per cent. calcium chlorid. The blood serum calcium before injection was 10.1 mg. for each 100 c.c.; 0.66 c.c. of a 10 per cent. solution of calcium chlorid was injected. Six minutes after injection it was 11.7 mg.; fifteen minutes after, 12.8 mg.; thirty minutes after, 10.1 mg.; one hour after, 9.7 mg., and two hours after, 10.1 mg.

May 16, 0.66 c.c. of a 10 per cent. solution of calcium chlorid was injected. Blood serum calcium before injection was 9.4 mg. for each 100 c.c. Five minutes after injection it was 10.4 mg.; fifteen minutes after, 9.9 mg.; thirty minutes after, 10.3 mg.; one hour after, 10.5 mg., and two hours after 10 mg.

Dog G166. Jaundiced.—March 20, 1923, under ether anaesthesia and employing sterile technic, a median line incision was made, and the common bile duct brought up and

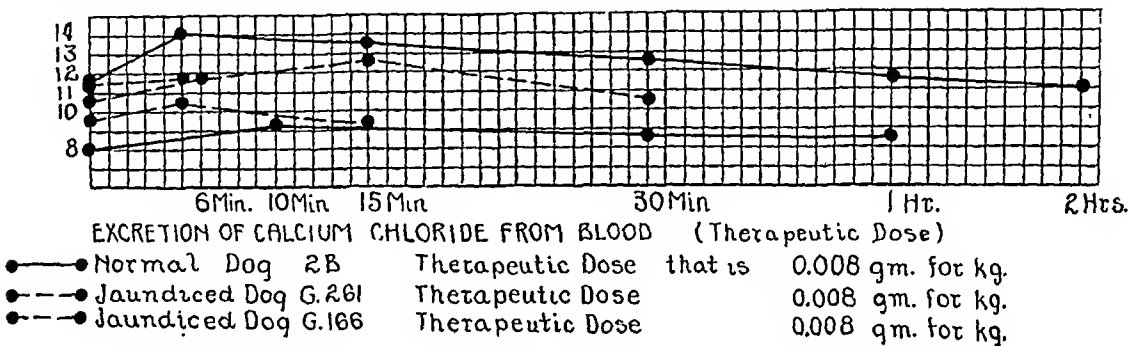


FIG. 2.—Chart showing the curve of excretion from the blood of therapeutic doses of intravenous calcium chlorid.

doubly ligated; a section of about 1 cm. was removed. April 20, an unsuccessful attempt at reconstruction of the bile duct had been made.

May 19, 1923, the dog was severely jaundiced. The body weight was 7.8 kg.; the therapeutic dose was 0.65 c.c. of 10 per cent. solution of calcium chlorid. The blood serum calcium before injection was 11.2 mg. for each 100 c.c.; 0.65 c.c. of a 10 per cent. solution of calcium chlorid was injected. Five minutes after injection it was 11.2 mg.; fifteen minutes after, 11.4 mg.; thirty minutes after, 9.9 mg.; one hour after, 9.9 mg., and two hours after, 10.4 mg.

RATE OF EXCRETION OF TEN TIMES THE THERAPEUTIC DOSE OF CALCIUM CHLORID GIVEN INTRAVENOUSLY IN NORMAL AND IN JAUNDICED DOGS

Dog G267. Normal.—The body weight was 7.5 kg.; the therapeutic dose was 0.6 c.c. of a 10 per cent. solution. (This animal, for nine days previous to this date, had been given increasing multiples of the therapeutic dose, beginning with the therapeutic dose for this body weight of 0.6 c.c. and receiving 5.4 c.c. May 3, 1923.)

May 4, 1923, 6 c.c. of a 10 per cent. solution of calcium chlorid was injected. The blood serum calcium before injection was 12.3 mg. for each 100 c.c. Six minutes after injection it was 26.3 mg.; ten minutes after, 25.8 mg.; fifteen minutes after, 25.2 mg.; thirty minutes after, 22.4 mg.; forty-five minutes after, 19.8 mg.; one hour after, 21 mg.; two hours after, 11.3 mg., and twenty-four hours after, 9.6 mg.

May 7, 6 c.c. of a 10 per cent. solution of calcium chlorid was injected. The blood serum calcium before injection was 12.7 mg. for each 100 c.c. Five minutes after the injection it was 26.8 mg.; fifteen minutes after, 22.7 mg.; thirty minutes after, 22.1 mg.; one hour after, 19.6 mg.; two hours after, 16.6 mg.; three hours after, 15.3 mg.; four hours after, 13.4 mg. and five and one-half hours after, 11.5 mg.

Dog G166. Jaundiced.—March 20, 1923, under ether anaesthesia and employing sterile technic, a median line incision was made and the common bile duct brought up and doubly ligated; a section of about 1 cm. was removed. April 20, an unsuccessful attempt at reconstruction of the bile duct had been made.

May 17, 1923, the dog was severely jaundiced. The body weight was 7.8 kg. Six and five-tenths cubic centimetres of a 10 per cent. solution of calcium chlorid was injected intravenously. The blood serum calcium before injections was 10.5 mg. for each 100 c.c. Five minutes after injection it was 17.7 mg.; fifteen minutes after, 15.6 mg.; two hours after, 12.7 mg.; three hours after, 11.2 mg., and four hours after, 10.7 mg.

THE LETHAL DOSE OF CALCIUM CHLORID (AQUEOUS 10 PER CENT. SOLUTION)
INJECTED INTRAVENOUSLY INTO NORMAL AND JAUNDICED DOGS AT THE
RATE OF 1 C.C. A MINUTE

Dog G267. Normal.—The body weight was 6.8 kg. May 7, 1923, under local anaesthesia and employing sterile technic, the right femoral vein was exposed and

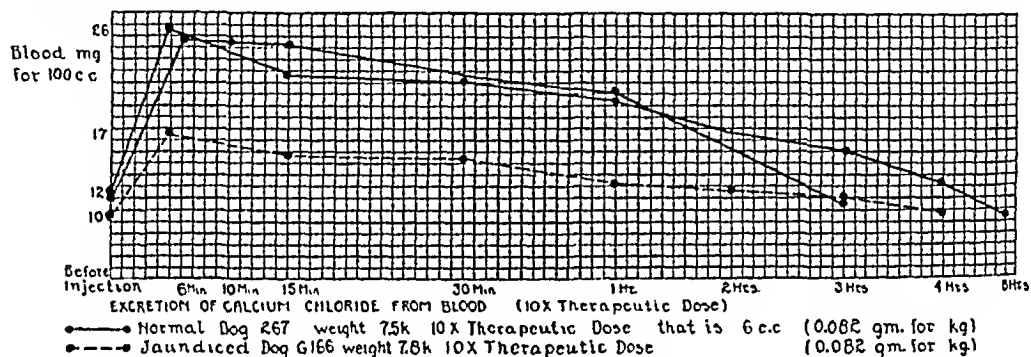


FIG. 3.—Chart showing the curve of excretion from the blood of ten times the therapeutic doses of intravenous calcium chlorid.

brought up, a cannula was inserted, connected with a burette containing 10 per cent. calcium chlorid under constant pressure. The solution was allowed to run at a rate of 1 c.c. a minute. When 13 c.c. had been injected the respirations were slower and deeper. When 15.3 c.c. were injected, the animal was seized with tonic convulsions and expired.

The dog received 15.3 c.c. of a 10 per cent. solution, or 1530 mg. calcium chlorid, which was equal to 225 mg. for each kilogram of body weight, an amount equal to 27.21 times the therapeutic dose. The blood serum calcium before injection was 11.5 mg. for each 100 c.c., and at death it was 36.5 mg.

Dog 2B. Normal.—The body weight was 10.7 kg. May 11, 1923, calcium chlorid was injected, using the same technic as in the previous experiment. When 4.5 c.c. were injected the animal was licking its mouth, swallowing rapidly, and respiration was increased. After receiving 5.5 c.c. the animal vomited; after 9.5 c.c. the rate of respiration was increased; after 11 c.c. the muscular tone was increased, after 13.5 c.c. respiration was markedly increased; after 15 c.c. there were spasms of the diaphragm; after 24.5 c.c. there were violent expiratory efforts, and when the animal had received 30.8 c.c. it had a generalized tonic convulsion and expired.

The dog received 30.8 c.c. of a 10 per cent. solution, or 3080 mg. of calcium chlorid, which was equal to 287.85 mg. for each kilogram of body weight, an amount equal to 34.89 times the therapeutic dose. The blood serum calcium before injection was 10.3 mg. for each 100 c.c., and at death it was 42.9 mg.

Dog G261. Jaundiced.—The body weight was 7.5 kg. May 2, 1923, under ether anaesthesia and employing sterile technic, a median line incision was made, and the

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common duct brought up and exposed for a distance of 1 cm. It was ligated distally and proximally, and about 8 mm. of duct between the ligatures removed.

May 18, calcium chlorid was injected by the same technic as in the previous experiments. When 7 c.c. was injected the dog was licking its mouth. After receiving 10.5 c.c. the animal vomited; after 15 c.c. there was prolonged expiration with questionable stridor; after 16 c.c., grunting respiration; after 17 c.c. there was a marked effort at swallowing; after 19 c.c., generalized tonic convulsion; after 21 c.c., grunting expiration, and after 22.8 c.c. the animal expired.

The dog received 22.8 c.c. of a 10 per cent. solution, or 2280 mg. of calcium chlorid, which was equal to 304 mg. for each kilogram of body weight, an amount equal to 36.8 times the therapeutic dose. The blood serum calcium before injection was 10.3 mg. for each 100 c.c., and at death it was 26.9 mg.

Dog G166. Jaundiced.—The body weight was 7.8 kg. March 20, 1923, under ether anæsthesia and employing sterile technic, a median line incision was made, and the common bile duct brought up and doubly ligated; a section of about 1 cm. was removed. April 20, an unsuccessful attempt at reconstruction of the bile duct had been made.

May 21, the dog was severely jaundiced. Calcium chlorid was injected using the same technic as before. A median line incision was made in the neck, and both vagi were sectioned six hours previous to starting the injection; 1/1500 gr. of atropin was given fifteen minutes before the injection and repeated ten minutes later. When 7 c.c. was injected the animal developed clonic muscular spasm. After receiving 17 c.c., there was increased restlessness, and general behavior as to increased muscular activity as above; after 36 c.c. the animal expired.

The dog received 36 c.c. of 10 per cent. solution, or 3600 mg. calcium chlorid, which was equal to 469.23 mg. for each kilogram of body weight, an amount equal to 56.8 times the therapeutic dose. The blood serum calcium before injection was 10.9 mg. for each 100 c.c., and at death it was 38.7 mg. (Table I).

TABLE I.

Summary of Results of Lethal Injection of Calcium Chlorid.

		Weight, kg.	Lethal dose, mg. for each kg.	Times the therapeu- tic dose	Blood calcium		Mg. of calcium chlorid for each mg. increase in blood calcium
					Before	After	
Normal dogs	G267	6.8	225	27.27	11.5	36.5	9.0
	2B	10.7	287.85	34.89	10.3	42.9	8.82
Jaundiced dogs	G261	7.5	304	36.8	10.3	26.9	18.31
	G166	7.8	469.23	56.8	10.9	38.7	16.87

The figures in the last column of the tabulation were obtained by dividing the number of milligrams of calcium chlorid taken for each kilogram of body weight by the number of milligrams for each 100 c.c. increase in the blood calcium content. These figures show that it requires approximately double the amount of injected calcium to raise the blood serum calcium content of the jaundiced dog to the same level as that of the normal dog, in spite of the fact that the blood calcium content is practically the same in the jaundiced and normal dogs both before and after injection of a lethal dose, suggesting a

calcium deficiency in the jaundiced animals which is not apparent in the blood serum calcium taken before the injection. This is borne out by the observation that although the lethal dose is larger in the jaundiced animal, the blood serum calcium contents taken at death are within a reasonable range of equality.

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CANCER OF THE THYROID

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A KNOWLEDGE of the pathology and clinical course of cancer of the thyroid gland is of the utmost importance to the surgeon and the general practitioner as well, but far more important is the recognition and removal of precancerous conditions. I make this statement especially of cancer of the thyroid, rather than cancer in general because we have formed the opinion that radical removal of the thyroid, after it is possible to diagnose cancer clinically, is a useless procedure in so far as cure is expected. In every case of cancer of the thyroid, the diagnosis having been made clinically, which we have treated, death has been hastened by operation. Cancer has been found microscopically in a number of apparently benign adenomata, which we have removed however, and prolongation of life has been commensurate with cancer in other organs, possibly better. It has been our experience that cancer of the thyroid is rarely primary, but that it develops in practically every case in adenomata of years duration. This at once suggests that cancer of the thyroid could be eliminated in great part at least, by the early removal of all adenomata, and this is what we will attempt to show in the following data.

Series of goitre cases examined 3640. Of these, nine were diagnosed clinically as cancer. Four (4) of these nine were removed. One (1) died 18 hours after operation—sudden. One (1) died 10 days after operation—general weakness. One (1) died 6 months after operation—rapid growing recurrence. One (1) died 9 months after operation—recurrence.

Of the remaining five (5), two were needled with radium and one died twelve days following, from œdema of larynx, the other is living after two months. Other four which were considered inoperable could not be traced. Of 850 thyroidectomies for adenomatous goitres, carcinoma was found microscopically in twelve cases and pronounced as doubtful in eight.

Of the twelve, two had recurrences within two years, the first in the submental region, this was removed and patient is still living after two months. She also had a recurrence of the right breast which is growing slowly, and which because of her condition it was thought inadvisable to remove.

The second case had a recurrence at the site of the right lobe and died twenty months after her first operation.

Of the eight doubtful cases, one had a recurrence of the cervical glands on the left side, and died thirteen months following without further surgical intervention.

Of the seventeen remaining cases, ten as positive and seven as doubtful—twelve are living and free from recurrence after three years four after two years, one after one year.

Of the 3640 cases examined, there were 1242 thyroidectomies for all types of goitre from January 1, 1919 to January 1, 1923. Of these, sixteen were truly cancer, while eight were doubtful. A true percentage of 1.3 per cent. and a doubtful percentage of about 2 per cent. of all operated cases during this time. Of all cases examined, cancer occurred in the doubtful percentage of about 0.7 per cent. or less than 1 per cent.

From the above figures we find that while cancer of the thyroid, on the surface is not very frequent, yet we do find that after a thorough microscopical



FIG. 1.—Cancer of thyroid.

examination of each specimen removed, that it is more frequent than ordinarily supposed, and it is even possible that we are still overlooking a number of carcinomata by our present method of sectioning. In our laboratory we have been sectioning only those gross areas which appear suspicious to the naked eye—occlusion of the vessels and so on. In adenomata, carcinomatous areas have been found in almost any area within the periphery of the gland, where degenerative changes are in progress.

Symptoms.—As was remarked earlier in the paper, it is not possible as yet to diagnose cancer of the thyroid early, because it is seldom primary, but rather occurs in adenomata of long standing, and when it finally displays itself in the surrounding structures or outside the periphery of the adenoma it is too late to effect even a palliative cure. Pain referable to a goitre and of rather frequent occurrence must always be looked upon as a suspicious sign. Dis-

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tention of the veins of the neck, with extensive collateral circulation over the chest and even the abdomen must be looked upon with suspicion, although this may occur in benign substernal goitres. Enlargement of the cervical glands; a changing of a soft degenerated adenoma into a hardened nodular one, an increasing difficulty in breathing, swallowing, etc., are all evidence of cancerous changes. Diminished and roughened outline of the trachea on X-ray plates. The prognosis is necessarily bad.

Treatment.—All adenomata should be removed as soon as diagnosed.



FIG. 2.—Needling cancer mass with radium. Needles are of 10 mg. each.

Surgery offers a 100 per cent. cure in adenomata of the thyroid with a mortality of less than 1 per cent. in all cases. If toxic, of course proper judgment should be used as to ligation, time to operate, etc. X-ray and radium have no place in the treatment of adenomata, in my opinion, and are more apt to do harm than good.

If the above treatment were carried out, cancer of the thyroid would be reduced to a minimum. When cancer has advanced however, to a stage where a clinical diagnosis is possible, then the method of treatment becomes problematical. At present I feel that the outlook is hopeless and that they will do just as well if left alone. I may be wrong. I do not, however, believe that surgery is indicated. Possibly needling with radium, at present offers the best means at our disposal. Deep X-ray therapy may find its place in the

treatment of thyroid cancer but I feel that it may do damage in the destruction of the parathyroid bodies.

Technic for Needling with Radium.—The wound is opened and the muscles separated as in the first step of a thyroidectomy. The needles are then inserted into one lobe of the mass, each needle being about $\frac{1}{2}$ inch apart. The wound is left open and the needles removed in 12 hours, the following morning, or twelve hours later the wound is closed. The patient is then kept under observation for four weeks. Usually after two or three weeks the mass becomes oedematous and there is some danger of strangulation. About the fourth week the other lobe is needled.

Following this treatment should be given a prolonged course of X-ray therapy.

RESUSCITATION BY DIRECT MASSAGE OF THE HEART IN CARDIAC ARREST*

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AND

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OUR purpose in presenting this case of cardiac arrest, which occurred during an exploration of the upper abdomen of a patient under ether narcosis, is: *First*, to call attention to the efficiency of cardiac massage in reëstablishing heart action in such a catastrophe. *Second*, to emphasize the simplicity of the procedure. *Third*, to suggest that restorative measures are never exhausted or completed in such an accident unless direct cardiac massage has been tried.

Such accidents, though infrequent, have been seen by every experienced surgeon and anæsthetist. They present emergencies that are not easily forgotten, as they usually occur with startling suddenness and with no antecedent warning. Attempts at resuscitation are rendered inefficient, in many cases, by the demoralizing suddenness of the accident, and by the knowledge that restorative measures must be quickly successful or they will fail altogether.

It should not be forgotten in the management of these emergencies, that in massage of the heart we have a procedure which is sometimes successful even when the heart beat has been absent for several minutes. The number of recorded cases in which this method has been tried is small, and it has been successful in only about 25 per cent. of the cases in which it has been used; but when successful, it has acted dramatically, actually appearing to have restored the dead to life.

Heart massage implies manipulation of the heart directly, or indirectly through the diaphragm. Its purpose is to furnish rhythmic mechanical stimuli to the myocardium, and also to maintain a small circulation of the blood through the heart chambers and thus provide nutrition of the heart itself and of the vital centres of the brain. Obviously it can be successful only in those cases where arrest of the heart is due to reflex inhibition through the vagus, or to the presence in excess, of some quick acting and powerful poison, such as we have in our general anæsthetic agents, ether and chloroform. It is hopeless to expect results when the cardiac arrest is due to chronic disease of the heart muscle or of its vessels.

The subject was first studied experimentally in 1874, when Schiff showed that dogs which had been killed by chloroform inhalation could be restored by direct cardiac massage, but in no other way; and that this method could be depended upon with some certainty when the heart had been quiescent as long as 11-1/2 minutes. Prus reported that the circulation in dogs could

* Read before the Philadelphia Academy of Surgery, May 5, 1924.

occasionally be restored after a cessation of half an hour. Crile and Dolley¹ maintain that massage should be performed simultaneously with artificial respiration.

Cardiac massage was first tried on a human in 1898, but the first successful case is reported by Darling and Lane in 1902. Bost¹¹ in 1923 was able to find only 75 cases in the literature, to which he added two more. In 20 per cent. of these cases the procedure was completely successful, in a few more the circulation was temporarily restored, for a few hours or days. To Bost's 77 cases we have added 23 found in the literature since 1918, which he did not include. This makes a total of 100 recorded cases and with the one we are reporting 101. But 25 of these cases were successful, including our own.

It had been our impression that accidents of this kind were most apt to occur in those who had taken their anæsthetic badly and when the induction had been accompanied by coughing and struggling, but the published reports do not bear this out. On the contrary in the few records in which this point is mentioned it is specifically stated that the induction of the anæsthesia had been particularly smooth.

In recent British literature there are careful articles by Norbury,¹² Gunn¹³ and Levy,¹⁴ giving the results of their clinical and experimental studies in this subject. Their findings are so remarkably similar in character they may be summarized as follows:

Artificial respiration they all agree is most important in conjunction with cardiac massage and must not be neglected. At times natural respiration may continue for several minutes after the heart has ceased beating but it is inefficient and little or no air is actually drawn into the lungs. Artificial respiration should be considered part of the technic of cardiac massage.

All these writers urge that massage be instituted early—within two to three minutes after the cessation of the heart beat. The importance of this is also emphasized by the published case reports. Only one patient was permanently revived when massage had been started after a lapse of longer than ten minutes after the heart had become quiescent.

The inefficiency of drugs is emphasized also by these studies. Gunn finds that adrenalin, in very dilute solutions, will counteract the effect of chloroform and of chloral on the perfused isolated mamalian heart; but in the intact animal, strong adrenalin solution thrown directly into the ventricles or heart muscle is apt to set up a ventricular fibrillation that will not be recovered from. It is obvious that if the heart and the circulation have stopped, drugs introduced under the skin cannot be absorbed. This was certainly demonstrated in the case which we are reporting. When the pulsations of the heart have been restored, but are still slow, feeble and irregular, intravenous infusion of salt solution containing a small quantity of adrenalin is advised by Norbury; Levy recommends pituitrin intravenously in the same circumstance.

Levy claims that the entire function of massage is to maintain the circulation and not to furnish mechanical stimuli. We cannot follow his argument. There is no doubt that the heart can be so squeezed as to cause

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it to empty and partially refill, and thereby maintain a feeble and inefficient circulation, enough perhaps to keep the vital centres viable; but that cannot be the entire rôle of cardiac massage. The functions of irritability and contractility are eminently characteristic of the myocardium. They begin to be manifest in earliest embryonal life, when the heart of chicken and doubtless of other embryos, begins rhythmic contractions almost before the mesenchyme has become differentiated to muscular tissue about the primitive heart tube, and they continue without interruption for many years in man and other long lived animals. The greatest mechanical imperfections of the heart, the greatest changes in its histology, in its nutrition, or in its innervation are not sufficient to destroy its irritability or its contractility until the myocardium is too exhausted to respond, or until it has used up all of its stored nutriments. It is well known that the heart responds to any sort of irritation in the same way as other muscular tissues, namely, by contraction. All surgeons have seen various muscles twitch and contract when cut across, or have seen the muscles of an amputated limb respond by irregular contraction to the stimuli of pinching. A frog's heart separated from its body will beat for a period and finally become quiescent. After this time it will respond to mechanical stimuli of various kinds by strong contraction, and will continue to do so for hours, if it is kept moist. There is no reason to suspect that the mamalian heart differs in its irritability from the skeletal muscles of the same animal, or from that of cold blooded animals. Indeed they are known to react alike, save only that the mamalian heart loses its irritability earlier than that of cold blooded animals. Massage of the heart may, and probably does, maintain a feeble trickle of blood through the coronary circulation and perhaps through the brain, but it is not very efficient for this purpose. Its main effect certainly is to furnish a series of rhythmic mechanical stimuli. At first the heart resumes its function with one or perhaps two contractions to each stimulus; these natural contractions are infinitely more efficient to propel the blood than the squeezing of the hand, and must soon improve the nutrition of the myocardium, or remove enough of the toxic material so that it can resume automatic function.

1. *Methods of approach.* The first method employed was the thoracic route, in which an osteoplastic flap is turned back, giving direct access to the heart. This method has been abandoned; it is time consuming when time cannot be spared, it tends to increase shock and usually causes pneumothorax. But the consumption of time is the principal objection to this avenue of approach.

2. *The abdominal subdiaphragmatic route.* This is the method usually employed, as it is quick and easy, and seems the most natural approach. In many cases, the necessary midline upper abdominal incision will have been made when the accident occurs. Through this incision the hand is inserted and the heart after being grasped between the thumb and forefingers is rhythmically squeezed against the chest wall, which is supported on the outside by the

other hand. This method may fail, especially in adults, for in them the base of the heart, where contractility chiefly resides, and whence the heartbeat is normally propagated, cannot be reached through the diaphragm. If the heart has not been restored to activity within two minutes, further time must not be lost before incising the diaphragm and directly stimulating and massaging the heart.

3. *The abdominal transdiaphragmatic route.* Through an upper abdominal incision the diaphragm and pericardium are incised in an anteroposterior direction, the heart seized with the hand and rhythmically squeezed. By this method the heart has nearly always been induced to start beating, at least for a while, but the approach is difficult, especially the suturing of the diaphragm after the procedure is completed and this suturing, of course, must not be neglected.

Bost² advocates separating the diaphragm from its insertion to the ribs by a two inch transverse incision. This is stretched, the hand plunged into the left thoracic cavity and the heart can then be effectively massaged through the unopened pericardium. He states that this is an easier route of access to the heart, and that the hand plugs the diaphragmatic opening and usually prevents pneumothorax, and finally that the subsequent suturing of the diaphragmatic wound is easier than in any other method.

Whatever the approach the heart must be compressed at a slow rate, about 20 times a minute, for when it resumes its beat it will start slowly. When rhythmic beating is initiated, the massage should be stopped, for fear of interfering with the natural beat. During the whole time that cardiac massage is being used, artificial respiration must be continued until this function is again taken up automatically.

The necessity for rapid action must be borne in mind. Although three recoveries^{8, 11} have been reported where the arrest is said to have lasted for ten minutes or more, yet time passes very rapidly in such emergencies, and the duration may have been overestimated. The sooner massage is instituted after cessation of the heart beat, the greater is the probability of resuscitation. Hypodermic stimulation should be given coincidently; it seems obvious that the intraventricular administration of adrenalin, as advocated by Crile, will be more certain and more efficient in its action if combined with massage. If the heart actually is arrested, it is doubtful if anything except direct massage will restore its beat.

CASE E. R.—(Germantown Hospital, No. 615.) A colored teamster, age thirty-one entered the Germantown Hospital, March 13, 1924, on account of abdominal pain and digestive disturbance of three years' duration. Study in the medical ward led to a diagnosis of probable gastric or duodenal ulcer, and on March 24th he was transferred to the surgical service, and operated upon the same day. He received the usual pre-operative preparation, including morphine sulphate, grains $\frac{3}{4}$, and atropine sulphate, grains $\frac{1}{150}$ hypodermically one-half hour before starting anesthesia. Physical examination revealed no abnormality of the heart or lungs. The anæsthetic used was ether, given by the professional anæsthetist by the open drop method.

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The patient started his anæsthetic well, but was very much excited during the second stage, struggled violently, breaking a heavy strap across his knees, and did not become quiet for several minutes; however, he was ready for operation within the usual time, and when the operation was started he was in good condition and fairly well relaxed. His pupils still reacted to light.

An upper abdominal right rectus incision was made, the stomach was picked up, and some traction made to expose the pylorus, when without warning he ceased to breathe, though the exposed viscera remained a good color. The pulse at the temporal arteries was at first strong but rapidly became weaker.

Artificial respiration was at once instituted but there was no response; Even rhythmic testicular stimulation was unavailing. In about ten minutes it was reported that the pulse could no longer be felt at the temples. Hypodermic medication was then ordered. The operator inserted his right hand into the abdomen through the abdominal incision and felt that the heart was absolutely quiescent. At the same time, it was noted that the exposed abdominal organs and mucous membranes began to show a very deep cyanosis, rapidly approaching blackness.

The heart was then gently grasped by the thumb and fingers of the right hand and rhythmically squeezed against the chest wall at the rate of about 20 times a minute. Artificial respiration was continued synchronous with this process of cardiac massage and 20 minims of adrenalin and $1/75$ of a grain of atropine sulphate, which had been ordered previously were injected into the deltoid muscle. After 15 or 20 squeezes the heart began to respond to the mechanical stimulation by a feeble tremor which presently was followed by several twitchings and in about three minutes from the time the massage was first started it had resumed its regular contraction but at a very slow rate. The pulse then gradually returned at the temples, and the cyanosis began to diminish. After several more minutes, voluntary respiratory efforts were made; these became deeper and more efficient and regular, and artificial respiration was finally discontinued about 15 minutes after it had been commenced. It should be noted that at the time the adrenalin and atropine were injected there was no circulation to absorb these drugs from the tissues; and that the heart had resumed its beating before they could have been absorbed.

The operation which had been planned was then proceeded with. A gastro-enterostomy was done for a duodenal ulcer that was palpable and visible and a chronically diseased appendix was removed. The subsequent course of the patient was uneventful and he was discharged, free from symptoms, on April 8, 1924.

We have found 23 cases in the literature since 1918 which were not included in those collected by Bost in his article in 1923. Fourteen of these cases were reported by Norbury, who claims 3 successes.

CASE I.—The patient, a French soldier,² had been wounded with retention of a shell fragment in the left lung. During the operation by LÉFÈVRE for its removal, the patient's cardiac action ceased without warning. As the thorax was already opened, the wound was enlarged, the heart grasped through the pericardium, and rhythmically squeezed. It soon resumed its beating, and the wound was closed. The patient recovered consciousness, but died the next day. The cause of death was not evident.

At the same meeting of the Société de Chirurgie de Paris, CHEVASSU reported a somewhat similar case.

CASE II.—The patient was brought to LaPitié Hospital, apparently dead from a stab wound in the left chest. Although it seemed useless, the skin was hurriedly prepared and thoractomy was done. This revealed that there was a penetrating wound of the right ventricle and that the heart was almost motionless, though it was observed to twitch from time to time. The ventricular wound was sutured, which was enough stimulation to start cardiac contraction. The patient was sent to the ward, and for a time survived,

but died on the second day of sepsis. The autopsy showed a purulent pericarditis very possibly the result of the somewhat hasty pre-operative preparation.

CASE III.—This patient, recorded by DALY⁴ was a patient in a British Base Hospital, who was almost ready to be returned to the front. During an enemy air raid, he was seriously wounded in the abdomen and left thigh and bled profusely. Although it was feared he might not survive the operation it was felt that the wounds must be repaired. During the operation his heart and respiration ceased; he was revived by subdiaphragmatic massage but died 22 hours later. Daly felt that this death was due to hemorrhage, and that if it had been possible to transfuse him, his life might have been saved.

CASE IV.—During an exploratory laparotomy under chloroform-ether mixture, another case reported by POWELL⁵ the patient's heart stopped, but it was quickly revived by cardiac massage. The ultimate fate of this patient is not stated.

CASE V.—SHIPWAY reports a patient⁶ who was a man of sixty years of age undergoing an exploratory operation under ether. When his stomach was pulled upon respiration ceased followed by a cessation of the heart beats. The usual measures of resuscitation failed, but subdiaphragmatic cardiac massage quickly revived him. The end result was not stated.

CASE VI.—Reported by APPERLY,⁷ Was a stout woman undergoing a pelvic operation under ether. The abdomen was opened; when she was raised into the Trendelenburg position, her heart and respiration ceased, and her heart, felt through the diaphragm, was perfectly flaccid and immobile. The table was promptly leveled, and the heart massaged; the circulation was soon restored and the operation proceeded with. Near the close of the operation she was again placed in the Trendelenburg position but her pulse became so weak and irregular that it could not be maintained and the level position had to be restored.

CASE VII.—HAIM. During a cholecystectomy, started under local and completed under general anesthesia, with Billroth's mixture of alcohol, chloroform and ether, the patient's heart and respiration stopped. Various measures were tried unsuccessfully for 20 minutes, when cardiac massage was begun. This restored the circulation after about five minutes, when the operation was completed. This patient made a good recovery from the anesthetic, and had a normal convalescence.

CASE VIII.—This patient reported by PETTY,⁸ was an elderly man, who was suffering from chronic indigestion. An exploratory operation was begun using chloroform and ether mixture for the anesthesia. The induction of narcosis was quiet, without struggling. When his stomach was exposed and the pyloric end pulled upon, respiration ceased, and then the heart ceased beating. After ten minutes' trial of ordinary measures, without success, cardiac massage was started. It was successful, but could not be given up for seven minutes, at the end of which time the pulse was full and strong. The operation was abandoned and the wound repaired. It healed *per primam* and the patient had a normal convalescence.

CASE IX.—COLEMAN,¹⁰ During an operation for gastro-enterostomy, the patient's heart and respiration ceased. Various measures were used unavailingly for one-half hour; at this time the heart was perfectly quiescent and flaccid. Cardiac massage and artificial respiration were started and persisted in for 45 minutes. After this time irregular cardiac contraction and occasional respiratory efforts were resumed, but they finally died away and ceased permanently after two hours.

CONCLUSIONS

I. The earlier cardiac massage is instituted after cessation of the heart beat, the greater is the likelihood of success. Time should not be lost waiting for hypodermic stimulation to act. If the circulation has actually stopped, it cannot act.

MASSAGE OF THE HEART IN CARDIAC ARREST

2. The quickest and the easiest method of approach is the best. This is usually the abdominal transdiaphragmatic route. If this is not successful within two or three minutes, the diaphragm should be incised, the heart grasped in the hand and directly stimulated.
3. No patient should be abandoned as beyond resuscitation until cardiac massage has been tried without success.
4. In about 25 per cent. of the recorded cases, cardiac massage has successfully resuscitated the patient.

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LATE RESULTS OF SPLENECTOMY FOR TRAUMATIC RUPTURE OF THE SPLEEN*

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THAT the spleen is not essential to life, has been proven beyond any doubt, and the justification for its removal under certain conditions admits of no argument, but that life proceeds in the same orderly fashion after removal, is a point on which the last word has possibly not been said. The results of splenectomy for the various anemias, tuberculosis, abscess, etc., cannot be offered in evidence because we are dealing in these cases with an abnormal spleen under abnormal conditions. In splenectomy for traumatic rupture, we are dealing presumably with normal spleens in normal individuals, and it is to these cases that we must look for information. In reviewing the literature on this subject, one is impressed forcibly with the fact that there has been very little attempt to follow such patients for any length of time and in any numbers. The remote consequences of splenectomy should properly be sought in a study of the changes taking place in the various functions of the spleen, but as these are at present, more or less hypothetical, such a method is not practical for clinical purposes. The functions of the spleen have recently been summarized by Kahn. The more important functions of the spleen, according to our present knowledge are:

(a) The formation of white blood-cells, particularly lymphocytes; blood platelets are produced under normal conditions in the spleen, but other organs may take on this function vicariously.

(b) The splenic pulp serves as a place where the red blood-cells are discarded and undergo destruction and phagocytosis by the macrophages. This is a selective function, and determines which cells are to undergo destruction and which are to continue in the circulation.

(c) The spleen is a storehouse for iron, especially the iron which is liberated from the decomposition of the blood tissues. The iron output is increased after experimental splenectomy and in the hæmolytic anemias.

(d) That the spleen plays an important rôle in digestion, internal secretion, or metabolism, has not been established. The organ does act as a mechanical filter for bacteria and other particulate bodies.

Kahn's conclusions regarding the effect of splenectomy, are in general, that there is a temporary anemia of both red cells and hæmoglobin, with a leucocytosis which persists for about a year, and that there is an increase in total fats and cholesterin in the blood following the operation. No changes

* Read before the Philadelphia Academy of Surgery, May 5, 1924.

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in the metabolism of sugar, CO₂, or in basal metabolism were noted. The statement is made, but not substantiated that splenic function is usually compensated within five weeks after splenectomy. Pearce and Krumbhaar, in an exhaustive experimental study on dogs, conclude that the effects of splenectomy may be summed up as follows:

1. An anemia of red cells and hæmoglobin, which tends to recover, the hæmoglobin being reduced more than the red cells.

2. Increased resistance of the erythrocytes.

3. Lessened tendency to jaundice when hæmolytic agents are administered.

Other changes which occur less constantly are also mentioned but are not applicable for clinical consideration. In general, the dogs returned to normal in from 2½ to 3 months. Wolferth has shown that substantially the same results follow splenectomy in albino rats. Krumbhaar and Musser found that in the monkey the anemia was much less marked than in dog or man, but that the resistance of the red cells was increased. Experimental work of many others, too numerous to mention, has laid particular stress on one or more of the above mentioned facts, but the findings in general are in accord with those of Pearce whose work included all of the data available at the time.

The results of splenectomy for traumatic rupture were reviewed by Lewerenz who collected the records of 135 cases up to 1900. Of these, 104 died; the majority in the first 24 hours, a mortality of 77.8 per cent. Since then the results have been far better, as is to be expected when viewed in the light of improvement in technic, earlier operation and better after-treatment. The operative mortality at present compares favorably with that of rupture of any other viscus. The later literature on traumatic rupture, and other matters pertaining to the spleen is apallingly voluminous, but the great majority of contributions consist in reports of one or more cases and are strictly surgical in character. There is a striking lack of published information regarding the more remote effects following removal of the presumably normal spleen. Staehelin collected the results in 21 cases, one of his own and twenty from the literature and personal communications. Analysis of this series gives valuable information regarding the blood picture following splenectomy, but the cases were followed only in one instance for as long as one year, and the majority for much shorter periods. It is apparent from analysis of these cases that no preliminary counts were made and in no instance with the exception of Staehelin's own case were the counts taken at regular intervals. The findings in all cases show a definite anemia of both red cells and hæmoglobin, but a wide variation in the degree of anemia. The leucocytes were increased in every case, but here the variations are even greater than in the red cells and hæmoglobin. Meyers reports a rather unique and intensive study of the blood picture in one case, in which 26 counts were taken following the operation, the first being taken after six hours and the last at the end of three months, at which time the patient's blood picture was on the up grade but still below normal. This study is not of any great value on account of the brief period covered. Hitzrot reported the results in five cases of traumatic rupture,

four of which recovered. His recorded observations cover periods of a few weeks or months but the impression is conveyed that the splenectomized individuals were all normal at the end of one year. In general the changes noted by Hitzrot were: 1. Anemia which gradually returned to normal in from 1 to 3 months. 2. Increased resistance of red cells. 3. Increased output of iron in stools. 4. Increase in total fat and cholesterol in the blood. 5. No change in opsonins and agglutinins.

The observations in 3, 4 and 5 are not especially significant as no preliminary tests were made and the normal figures are not constant. All four cases showed a leucocytosis varying from 19,800 to 68,000, but all were normal at the end of three months. No detailed blood counts are given.

Other changes following removal of the presumably normal spleen have been noted by many writers. These are (a) enlargement of the superficial lymph-nodes, (b) increased tendency to sleep, (c) increase in weight and appetite, (d) failure of proper growth, and (e) decreased resistance to infection.

A most interesting case is reported by Lee in which the patient had had splenectomy performed at the age of fourteen, for traumatic rupture. Fifteen years later Lee again opened the abdomen for intestinal obstruction and in the course of the operation found the entire small intestine studded with small tumors which looked like splenic tissue. Two of these were removed and were diagnosed as spleen by microscopic examination. Lee states that there were about 300 of these tumors, in the aggregate being equal to a normal spleen. The conclusion was drawn that spleen cells had been set free at the time of the rupture. This sort of thing may possibly be of importance in explaining the absence of anemia in some cases. The fact that accessory or supernumerary spleens occur in a percentage of cases, also has a definite bearing on the production of symptoms following splenectomy.

We wish to add to those already discussed, the reports of four cases in which the spleen was removed following traumatic subcutaneous rupture.

CASE I.—M. A., aged fourteen, admitted to University Hospital, September 12, 1921, complaining of pain in the abdomen. The patient had been struck in the abdomen by a blow of the fist in a fight. He suffered severe pain at the time and was taken home. The pain became progressively worse and he was brought to the hospital in the patrol. When admitted the patient was pale, restless and markedly shocked. He complained of severe generalized abdominal pain. The abdomen was quite rigid and peristalsis was exaggerated. Both flanks were dull and the point of maximum tenderness was located over the right lobe of the liver. Blood count: Red blood-cells, 3,950,000; white blood-cells, 32,000; hæmoglobin, 65 per cent.

Operation.—Right rectus incision. Peritoneal cavity full of blood. Liver found to be intact, but palpation disclosed the spleen partially detached from the pedicle and a small laceration on the anterior surface. The incision was curved to the left and splenectomy done. The wound was closed without drainage. Convalescence was uncomplicated and the patient was discharged on October 21st.

Since operation the patient has had two attacks of abdominal pain, both following dietary indiscretions. He was admitted to the hospital for study. An X-ray examination of the gastro-intestinal tract was negative.

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When seen two years after operation the patient was rather undersized, but had grown a good deal in the past two years. There was a moderate anæmia, as shown by the blood count, and a marked lymphoid hyperplasia of all the superficial lymph-nodes.

CASE II.—A. F., aged fourteen, admitted to Abington Hospital, February 16, 1922, complaining of pain in abdomen. He had been struck in the abdomen by a sled. This was followed at once by severe pain in the left side which was referred to the left shoulder. He was brought to the hospital at once. When admitted he was in pronounced shock, temperature 96, pulse 100, very poor quality. There is dulness in the left flank. Blood count: Red blood-cells, 3,400,000; white blood-cells, 28,000; hæmoglobin, 62 per cent.

Operation.—Left rectus incision. Peritoneal cavity contained large amount of fluid blood and clots in upper portion. Spleen ruptured. Splenectomy done. Wound closed without drainage.

Convalescence uneventful. Discharged March 7. One year and eight months after operation the patient was perfectly well. He had had no intercurrent infections, but the blood examination showed a definite though moderate anæmia. There was a general hyperplasia of the superficial lymphatics.

In January, 1924, this boy was struck by a train at a grade crossing and instantly killed.

CASE III.—D. K., aged sixteen, was admitted to University Hospital, February 8, 1920, complaining of pain in abdomen. While coasting, he had been thrown against a tree and "had the wind knocked out of him." He at once noticed a sharp pain in the left side and was unable to walk. The pain was also referred to the left shoulder and was particularly severe on inspiration. On admission to hospital, he was pale and apparently in great pain. The temperature was subnormal, the pulse small and running, rate 140. The respirations were slow, labored and painful. Abdomen, tense, tender, silent and dull to percussion in the left flank.

Operation.—Left rectus incision. Peritoneum filled with blood and clots, especially in the left upper quadrant. The spleen was completely detached from its vessels and lying free in abdomen in two pieces. The vessels seemed to be located in a mass of bloody cellular tissue and were oversewn. A large pack was placed over the pedicle and the wound drained with a rubber tube. The patient was given 750 c.c. of salt solution intravenously on the table.

The following day the blood picture was: Hæmoglobin, 61 per cent.; red blood-cells, 4,250,000; white blood-cells, 25,000. The differential count showed: Polymorphonuclears, 65 per cent.; lymphocytes, 27 per cent.; large mononuclears and transitionals, 7 per cent.; eosinophiles, 1 per cent. The packing was removed on the seventh day. Following removal of packing the temperature gradually climbed, and on March 2 the wound was reopened with the idea that a residual abscess had formed. No abscess was found.

The patient was discharged April 22 still running a temperature, but with a healed wound and no other complications.

In November, 1923, three years and nine months after operation, the patient has gained considerable weight but has, as he puts it, no "pep." There is a moderate anæmia, as shown by the blood count, and a generalized lymphoid hyperplasia.

CASE IV.—E. M., aged seven years, was admitted to Abington Hospital, November 11, 1920, complaining of pain in the abdomen. He had been struck by an automobile, which is said to have passed over the abdomen. He was admitted to hospital in the evening of same day in state of moderate shock. Temperature 97, pulse 120, respirations 24. Abdomen rigid, flat, no tenderness over liver or spleen. Diagnosis of intraperitoneal injury made, although unable to localize anything.

Operation.—Right rectus incision. Cavity full of blood. Spleen palpated and found to be ruptured. Left rectus incision (high) added and splenectomy done. Pulse rose to 180 during operation and saline solution given intravenously. Blood counts November 17, December 1, post-operative: refer to Table I.

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Convalescence was uneventful and patient was discharged in good condition December 8. Examination three years after accident. Patient has grown quite tall, but has not gained weight as he should. He has had measles, whooping cough and repeated colds and sore throat since operation. His mother says that he does not seem to be very energetic. There is a rather marked anæmia with 65 per cent. of hæmoglobin, but a normal leucocyte count. There is a generalized lymphoid hyperplasia.

TABLE I
Table of Blood Count Results

Case	Time in relation to operation	Hb. Per cent.	RBC.	WBC.	Differential			Fragility of RBC. Platelets				
					Per cent.	Per cent.	Per cent.					
I.	Pre. op.....	65	3,950,000	32,000	..	..	..	..	..	..	..	..
	1 yr., 8 mo....	75	5,490,000	8,900*	66	24	10	0	0	..	..	..
	2 yrs., 2 mo....	80	4,160,000	5,600	60	..	10	3	0	0.70	0.30	200,000
	Age 14.											
II.	Pre. op.....	62	3,400,000	28,000	..	..	..	..	..	..	..	..
	27 days.....	56	3,160,000	15,500	..	..	..	..	..	..	..	..
	1 yr., 9 mo....	70	3,840,000	7,800	65	26	4	3	2	0.38	0.28	276,000
	Age 16.											
III.	24 hours.....	61	4,250,000	25,200	61	27	7	1	0	..	..	..
	1 week.....	62	4,200,000	23,000	68	18	13	0	1	..	..	..
	2 weeks.....	..	..	17,000	..	..	..	..	..	..	..	..
	37 days.....	70	4,100,000	14,000	68	28	3	1	0	..	..	..
	3 yrs., 9 mo....	86	4,380,000	9,400	59	26	15	0	0	0.45	0.25	320,000
	Age 16.....											
IV.	48 hours.....	..	..	25,000	..	..	..	..	..	..	..	..
	1 week.....	62	3,880,000	18,000	64	23	6	6	1	..	..	Excessive but not counted.
	30 days.....	72	4,320,000	12,000	58	28	7	5	2	..	..	Excessive but not counted.
	3 years.....	65	3,460,000	8,200	80	11	8	0	1	0.38	0.28	321,000
	Age 14.											

*Patient had an acute abdominal attack, during which two white counts were taken—16,206 and 15,000, showing normal reaction to injection.

The accompanying table shows the results of observations on the blood pictures of these individuals. These four cases have been followed for periods ranging from one year and nine months in the shortest to three years and nine months in the longest. It will be noted that in every instance the patient still has a mild though distinct anemia. The white cell count has returned in all to within normal limits. All have pronounced enlargement of the superficial lymph glands. All complain of tiring easily. The changes in the resistance of the red cells is not constant. The platelet count is low in all if we take 600,000 as normal. No marked change in the structure of the red cells is apparent. These patients were all adolescent boys, and normal growth and development has not in any way been interfered with by splenectomy. How then should patients who have had splenectomy done for traumatic rupture be regarded? Whatever else they may or may not have, they show a secondary anemia which while of mild degree, is quite definite. The symptoms which these cases exhibit

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have been attributed by various writers to many different things, but with the exception of the lymphoid hyperplasia, the symptoms might well be due to the anemia. If this be true, it follows that the anemia should receive active treatment, for from a standpoint of general health there is a great difference between three and four million red cells per cm. One individual is well—the other is, if not actually sick, at least below par. Does the fact that the anemia is due to removal of the spleen, make it different from any other secondary anemia from the standpoint of treatment? Injection of protein free splenic extracts will produce an increase in red cells and hæmoglobin in normal experimental animals, but Pearce and Krumbhaar found that feeding of fresh beef spleen to splenectomized dogs produced no change in the blood picture.

Leake has recently shown that there is a decided increase in red cells and hæmoglobin in normal men, following the oral administration of combined splenic and red bone marrow extracts, and he suggests that the procedure may be of value in the treatment of certain anemias. No data is available as to the value of such therapy in splenectomized individuals, but it would seem to be worth trying. The administration of iron by hypodermic or intravenous injection is indicated in these cases and in our series Case III which shows much the best blood picture of the four, was the only one to receive such treatment. Small blood transfusions during convalescence would seem a rational procedure in stimulating the blood forming organs at the time when such stimulation is most needed.

CONCLUSION

1. Individuals splenectomized for traumatic rupture usually show a definite and persistent anemia which in our series did not fully recover under the ordinary conditions of life, and therefore requires prolonged observation and treatment.

2. That the spleen exercises an important function, is evidenced by the hyperplasia of lymphoid tissue throughout the body, and of splenic tissue which remains after splenectomy.

3. Decreased bodily vigor and resistance, often noted clinically and experimentally, may depend on anemia, but in the present state of our knowledge, it is impossible to exclude endocrine or metabolic disturbances as yet unknown.

4. There is no evidence of such adverse influence on health or longevity as to contraindicate splenectomy for traumatic rupture, which is ordinarily the operation of choice.

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MALIGNANT TUMORS OF THE KIDNEY IN CHILDREN

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IT IS a well-known fact that the kidney is not a rather uncommon seat for malignant disease during infancy and childhood. The type of tumor found is in the vast majority of cases of the mixed embryonic type, though various names have been applied. In many respects these tumors have and still present the problems and diversities of malignant tumors of the testicle. By the realization of embryologic and pathologic information we have been able to see various similarities between these malignant tumors of the infant kidney and the teratoma testis. This is not at all surprising since we know that during the embryological development of the organism the genital and urinary tracts have origin in very close proximity, namely, the urogenital fold is the anlage of both the mesonephros and the genital gland. These tumors, mixed in constituent tissues, as in the case of testicular tumors, are highly malignant and great destroyers of life. They are a singular and characteristic renal growth and have presented great problems as to pathogenesis. The presence of such a case on the Urologic and Pediatric Services of the University of California Hospital has prompted this report because of the large size of the kidney tumor (4500 grams-9.9 pounds).

In reviewing the literature there have been found several cases, rather large and unusual in size. Van der Byl's (Bland-Sutton) case weighed 36 pounds; Spencer Wells' case (Ency-Franc: D'Urol.) weighed 19.8 pounds, while Israel's was 18.7 pounds and Shepherd's 10 pounds. Strong reported a remarkable bilateral case in which the first tumor removed by operation weighed over $2\frac{1}{2}$ pounds; about a month later autopsy revealed a tumor mass of 8 pounds in the remaining kidney. These cases are extraordinary, the usual size varying from 1 to 4 pounds.

CASE.—A. C., female of Italian parentage, age six years five months, entered the University Hospital, August 25, 1922, with the complaint of swelling of the abdomen. The family history was negative. In the past history, feeding and development were normal except that she did not talk or walk until fifteen months. The only disease she had had was diphtheria, eleven months (October, 1921), before entry. This responded to four injections of antitoxin but leaving a slight difficulty in speech. Following the attack of diphtheria in October, 1921 to December, the child appeared normal except for a poor appetite and no gain in weight. At this time no urinary or other symptoms were noted. Suddenly, in December, the patient was seized with abdominal pain. Examination by the parents disclosed a tumor in the left abdomen. There were no gastro-intestinal symptoms present. Several days later a fever developed which was of about one month's duration;

this was accompanied by vomiting during the same time. She was under the care of various physicians for several months, but the mass continued to increase rapidly in size up to one month before entry. At that time the parents think that it decreased some in size. Three weeks before entry the patient again was seized with severe abdominal pain, especially on the left side, radiating to the chest and pelvis. This was more or less continuous up to the time of entry but unaccompanied by urinary disturbances, fever, diarrhoea or constipation. During this time the patient had been up and around and playing. The parents think that there has been some loss in weight.



FIG. 1.—Photograph showing front and lateral view of patient. Note the marked abdominal distention.

Physical examination showed a thin, emaciated and underdeveloped girl lying in bed complaining of pain and discomfort in the abdomen. The skin was dark in color. Marked hypertrichosis on the back and extremities. The posterior cervical, axillary and inguinal lymph-nodes were palpable. The head showed some frontal bossing. The eyes, ears, and nose were negative. The tonsils were enlarged and reddened. The chest appeared shortened due to the abdominal protrusion. There was marked emaciation and flaring of the costal margins. The heart was pushed to the left about 2 cm. outside the left nipple line. No murmurs. The lungs were negative except for shallow expansion. The abdomen was markedly and uniformly

distended (Fig. 1). The superficial veins were markedly distended. Palpation revealed an almost stony hard resistance over the entire left side from the costal margin to the iliac crest and extending to the right as far as the midline above and the right posterior iliac crest below. The border thus formed was round and smooth, forming almost a straight line. In the left loin there was a bulging about the size of an orange and also of a stony hard consistency. The surface of the tumor being

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covered with the intestines gave the impression of cyst formation. There was no evidence of ascites. Extremities negative. No œdema. Rectal examination showed the pelvis to be free from tumor.

Laboratory Data. *Blood.*—Hæmoglobin (Sahli), 40 per cent.; red blood-cells, 3,272,000; white blood-cells, 15,500; polymorphonuclears, 75 per cent.; small mononuclears, 23 per cent.; transitionals, 2 per cent. The red blood-cells showed slight anisocytosis and central pallor but no poikilocytosis or polychromatophilia.

Urine.—Cloudy, amber cloud, acid reaction. No sugar or albumen. Sediment showed no red cells, pus cells or casts.

Blood Wassermann.—

Negative in two antigens.

Nose and Throat Cultures.—Streptococci and staphylococcus albus.

Von Pirquet.—Negative in 72 hours.

Phthalein.—First hour, 40 per cent.; second hour, 20 per cent. Total, 60 per cent.

X-ray Report.—Left chest rather mottled. Heart pushed upward by high diaphragm. No evidence of bone metastases.

A clinical diagnosis of sarcoma of the left kidney was made and the patient transferred to urological service.

Cystoscopic Examination.

—Under light ether anæsthesia a child's cystoscope was easily introduced. Bladder negative, ureteral orifices in normal position. Both ureters catheterized to the pelves with F5 bismuth catheters. The urine drained quite readily from the right catheter while that from the left was bloody and flowed very slowly. Functionally, phthalein appeared in three minutes on the right side and returned 30 per cent. in 15 minutes; no function was obtained on the left side. Pyelograms were made of both kidneys. The capacity of the left side was 8 c.c., while that of the right was 7 c.c. Examination of the plates showed the catheter in the left side to cross and lie outside of the right catheter far over on the right side of the body as though the patient had a right side double or horseshoe kidney. Pyelogram of right side showed that kidney in normal position with a normal appearing pelvis; the left side revealed a long oblique streak-like shadow extending from the top of the catheter upward to a point to the right of the spinal column at about the level of the IX dorsal vertebra. This was interpreted as meaning that the entire pelvis was invaded and destroyed and the shadow possibly might be extravasation of the pyelographic medium into tumorous tissue. Impression: Tumor of left kidney with ureter pushed out over its inner border so as to come to lie on the right side of the body (Fig. 2).

Operation.—Under ether anæsthesia the usual nephrectomy incision was made beginning from the left sacrospinalis muscle. Due to the tremendous size of the tumor the incision was extended across the lower abdomen over to the right side. The tumor mass was freed with difficulty due to the numerous adhesions everywhere. The tumor being rather cystic, was tapped with a trocar and about 100 c.c. of sanguinous fluid removed.

FIG. 2.—Photograph of pyelogram showing catheter in left side to cross and lie outside of right catheter due to the tremendous size of the tumor. The left pelvis shows a marked deformity. The right pelvis is normal in outline.

This made it possible to clamp and cut the pedicle which was smaller even than for a normal kidney. Following the removal of the tumor the patient went into shock. Stimulation with adrenalin and caffeine failed to help and the patient died at the close of the operation.

Pathologic Examination. Gross Pathology.—Specimen consists of spherical tumor weighing 4.5 kg. (9.9 pounds) and measuring 30 cm. in dimensions. It is surrounded by a firm, thick capsule, except in one place, where the capsule is thin and rupture of the mass has occurred. The tumor is fairly firm and elastic, except for small areas



FIG. 3.—Photograph of gross specimen of embryonic mixed tumor of reported case. The tumor was 30 cm. in diameter and weighed 9.9 pounds.

which have a cystic sensation. On section through the middle of the mass is seen a fibrous capsule varying from 0.1 to 1.0 cm. in thickness. The cut surface presents a varied picture due to multiple areas of hemorrhagic extravasation, degeneration and necrosis with multiple cyst formations. The major part of the mass, however, presents a solid yellowish-white cellular surface almost like lard in appearance, such as characterizes hypernephroma. The tissue is everywhere quite friable and lacks supporting stroma (Figs. 3 and 4).

Microscopic Pathology.—

Section shows a picture which is uniform throughout, characteristic of an extremely malignant adenocarcinoma. The individual cells are small, slender, columnar in type. The glands are well formed

and packed closely together with abundant proliferation in and about them of similar cells which have escaped bounds. Indeed, in areas the gland formation is almost entirely lost and replaced by solid fields of these small hyperchromic cells which show abundant typical and atypical mitoses. There is a small amount of loose stroma. Large areas of necrosis are seen. Blood-vessels are infrequent. No heterologous tissue is seen that would suggest a teratomatous origin. The glands are all lined by several layers of cells, often encroaching markedly on their lumina. The cells bear no direct resemblance to adult renal cells, nor does it reproduce the structure of any adrenal tumor either medullary or cortical. The cell type is characteristic of renal blastoma to which the origin of this tumor can undoubtedly be attributed. Other sections through the capsule show a few atrophic sclerosed hydro-nephrotic glomeruli. The remainder of the thinned-out parenchyma has been replaced by connective tissue and other chronic inflammatory elements (Figs. 5-8).

It belongs to the rare group of tumors of the kidney occurring more commonly in infants than adults, rapidly growing and malignant but showing little tendency to metastasize, known as embryonal adenocarcinoma. *Diagnosis.*—Embryonal adenocarcinoma of left kidney.

Discussion.—Since the tumor in the reported case is of the "mixed embryonic type," the one most usually found in infancy and childhood, the

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following discussion will therefore be entirely devoted to them. The study of malignant tumors of the kidney is an interesting one. Occasionally some of the other malignant types, as the hypernephroma or carcinoma (Franck), may be but rarely found. The benign types which are equally as rare, usually are fibromata, lipomata, fibrolipomata, adenomata and fibrocystic tumors. *Pathogenesis*.—Prior to 1870, malignant tumors of the kidney in children as well as in adults were considered as being of a carcinomatous nature. The terms "medullary cancer," "encephaloid cancer" or "encephaloid degeneration" were used to designate malignant renal growths (Parker, 1850; Shepherd, 1858; Barthez, 1864; Faludi, 1865, etc.).

In 1870, Catanni (Shannon) was the first to recognize the occurrence of sarcomatous elements in kidney tumors. Eberth, in 1872, noted that in reality there were tumors probably containing more than one type of tissue; he attempted to explain the presence of the muscle elements as being due to Wolffian body inclusions in the kidney. Cohnheim several years later (1875) thought that the striated muscle fibres, especially as found in rhabdomyomata, originated from the primitive vertebræ because, as he pointed out, the original anlage of the urogenital tract was in almost direct contact with these primitive somatic vertebræ. Jacobi, in 1884, collected cases in children from the literature and considered them as sarcomata. That these tumors were found at birth was noted by Paul in the same year when he reported "a congenital sarcoma of the kidney."

In 1894, there appeared the epochal paper of Birch-Hirschfeld. He collected a series of cases from the literature and brought forth the hypothesis that these "embryonic adenosarcomata" had their histogenic origin from the Wolffian body, thereby tending in a way to corroborate Eberth and Cohnheim. Several years later (1899) there appeared the very able discussion of Wilms. He not only agreed with Birch-Hirschfeld, but went further, deriving these tumors from embryonic tissue in its very earliest development, the myotome, sclerotome and nephrotome being considered in the process. By this hypothesis the striated muscle was derived from the myotome; bone and cartilage from the sclerotome or vertebral anlage; glandular elements from the mesenchyma. It must not be forgotten that at the stage indicated all the elements found in these tumors are in close proximity and that various degrees of displacement of these tissues may account for the variations encountered in these tumors. The hypothesis is a feasible one and probably is the one most readily accepted at the present time. Since Wilms, other very good discussions have appeared (Muus, Trappe, Jenckel, Klose, Garceau, Watson and Cunningham, Herzog, Ribbert, Busse, Fraser, etc.). Busse later attacked Birch-Hirschfeld's theory, bringing forth the fact that remnants of the Wolffian body had never been found in the kidney. He, as well as Muus, considered these mixed tumors as originating from the renal blastema and that the presence of the various tissue types could be explained by metaplasia. Ewing is of the opinion that the latter hypothesis is probably the most acceptable and by it can be explained why some tumors have the appearance of an embryonal adenocarcinoma.

The opinion on these embryonic mixed tumors is far from uniform and numerous names have been applied to them in the literature (adenomyosarcoma, embryoma, embryonal adenosarcoma, embryonic sarcoma, mesothelioma, embryonal adenocarcinoma, myxosarcoma, Wilms' tumor, teratoma, etc.). It can be seen that the terms merely designate the type of tissues found. Notable papers have appeared from time to time but very little, if anything, has been added to the original theories. It is possible that the simple tumors or so-called "sarcomata" may be explained upon Birch-

Hirschfeld's theory and the more complex types according to Wilms' theory. It is best for the present to consider them as being mixed tumors of some obscure embryologic origin. Indeed, the problem here is as perplexing as that of the testicular tumors. Probably the explanation of one will give some clue to the other.

The modern views regarding the pathogenesis of "mixed tumors" of the kidney may, therefore, be summarized in three groups (Fraser):

(a) That their origin is due to inclusions of Wolffian body tissue which has become displaced and persists among the cells of the developing kidney or metanephros (Birch-Hirschfeld).

(b) That aberrant cells of the myotome and sclerotome are responsible for the tumor growth and that the apparent mixed character is to be explained by the varying constituents which enter into the ultimate formation (Wilms).

(c) That these tumors are not due to inclusions from extra-renal sources, but are derived from the embryonic tissue of the true kidney, this tissue persisting and becoming metamorphosed into cellular structures of various types (Busse, Muus, Ewing).

Classification.—No definite classification of kidney tumors has as yet been arrived at, due to the uncertain knowledge of pathogenesis. Many classifications have been brought forward. We offer the following simple one from Eisendrath:

I. *Primary Neoplasms of the Parenchyma.*

1. Epithelial type.

(a) Adenoma.

(b) Carcinoma.

2. Connective tissue type.

(a) Benign—fibroma, myxoma, chondroma, leiomyoma and rhabdomyoma, angioma.

(b) Malignant—sarcoma.

(c) Embryonal adenomyosarcoma—also called teratoma or mixed-cell tumors.

3. Neoplasms due to misplaced adrenal rests—hypernephroma.

II. *Primary Neoplasms of the Renal Pelvis.*

1. Epithelial type.

(a) Papilloma.

(b) Papillary carcinoma.

(c) Epithelioma (squamous cell).

Pathology.—Grossly, these tumors may assume large proportions. They grow apparently from within so that they come to lie within a distended renal capsule, their rapid growth being a notable feature.

Macroscopically they usually are either solid opaque tumors or multiple cystic. If the latter, they have been found to be not unlike the congenital cystic kidney. These cysts have been found to contain clear or straw-colored fluid. Areas of necrosis and hemorrhage may occasionally be encountered as in other

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tumors. Cross-section shows lobulation of the tumor tissue or multiple cyst formation with areas of hemorrhagic necrosis. The former may usually be accounted for by the preponderance of glandular, fibrous, muscular or cellular tissue.

Microscopically a very complex picture may be presented and yet a characteristic distinguishing one. As the many names in the literature indi-



FIG. 4.—Photograph of cross-section of tumor showing multiple cyst formation, areas of hemorrhagic extravasation, degeneration and necrosis. Note the enclosing thick firm capsule.

cate, various types of tissues may be encountered. The picture most usually seen is a mixed embryonic one. According to Ewing "the usual composition is one of isolated tubules of high cylindrical or cubical cells with indistinct lumina surrounded by broad zones of indifferent spindle-cells, on which is based the designation of adenosarcoma." The rapid growing tumors are usually cellular, showing practically no differentiation. If these cells are in excess, the term "adenosarcoma" has been used to designate them. If the tubular elements are dominant as in the case reported the term "adenocarcinoma" has been applied. In some, abortive attempts at glomerular formation can be seen. Many other types of tissue are occasionally found such as smooth or striated muscle, elastic fibres, myxomatous tissue, cartilage, bone and fatty tissue. The whole picture is of a mixed embryonic type. Should metastases occur, they are usually of the cellular or sarcomatous type, although striated muscle cells have been reported in lung metastases. Fraser has brought forth the idea that these tumors may be of low malignancy at first,

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at which time it is mostly of adenomatous tissue and later changes to one of high malignancy, grows rapidly, assumes a sarcomatous structure and infiltrates quite markedly.

TABLE I.

Analysis of Statistics Relative to Incidence of Kidney Tumors in Human Beings.

	Author	Number of cases	Number of renal tumors	Percentage		
Frequency of kidney tumors	Kelynaek.....	4,500	9	0.2	May be as high as 2 per cent. (Wood)	
	Kuster.....	37,000	23	0.06		
	Wagner.....	4,505	9	0.019		
	Kaufman.....	1,035	87	8.00		
		47,040	128	0.25 (1 in 400)		
A. Adults	Fraser.....	15,000	7	0.04		
	Cheney.....	2,260	1	0.04		
	U. C. Hospital..... (1918-1923)	3,210	6	0.18		
		20,470	14	0.06 (1 in 2500)		
Relative frequency among tumors	Warthin.....	2,000	8	0.3		
	Williamis.....	8,371	25	0.4		
	Reiche.....	11,930	80	0.7		
	Kelynaek.....	1,400	6	0.4		
	Muller.....	521	3	0.5		
A. Adults		27,222	122	0.5 (1 in 200)		
	D'Espine and Piso....	383	78	18.0		
	Hirschsprung.....	29	15	49.0		
	U. C. Hospital..... (1918-1923)	62	6	9.6		
B. Children		484	99	20.4 (1 in 5)		
		Number of cases of renal tumor	Number in children			
Relative proportion of children to adults	Morris.....	132	45	34.		
	Albarran.....	247	63	25.		
	Rohrer.....	115	37	32.		
	Kelynaek.....	160	83	52.		
	Albarran and Imbert...	589	173	29.		
		1,243	401	32.2 (1 in 3)		
Relative frequency of mixed tumors to hypernephromata			Mixed tumors	Hypernephroma		
			No. of cases	Per cent.	No. of cases	Per cent.
	Israel.....	43	2	4.6	17	39
	Albrecht (Hyman)....	32	0	0.0	28	87
	Barney.....	74	0	0.0	27	36
	Wilson.....	92	4	4.3	71	76
	Watson.....	89	2	2.2	45	50
	Block (Israel).....	126	5	3.9	86	68
	Binney.....	114	31	27.0	43	38
	Hyman.....	40	8	20.0	28	70
	Albarran and Imbert...	380 (adults)	10	2.6	85	22
		220 (child.)	49	22.0	5	2
	Ipsen.....	42	2	5.0	17	40
	Derriek.....	29	4	14.0	18	62
		(Average).....	1,281	117	9.9	470

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Incidence.—Malignant tumors of the kidney in children are rather uncommon. An analysis of the accompanying tables yields some interesting data (Tables I-II). The frequency of renal tumor in adults is 0.25 per cent. (1 in 400), whereas in children it is much rarer—0.06 per cent. (1 in 1600). These figures would seem to indicate that the occurrence of renal growths in children is about four times as rare as in adults. In animals the rarity is even greater—

TABLE II.
Incidence of Kidney Tumors Among Animals.

	Author	Animal	Number of animals	Number of kidney tumors	Percentage	Remarks
Frequency of renal tumors in animals	Chicago Lab. of Bur. Animal Industry	Hogs	2,000	52	2.6	47 were embryonic adenosarcomas, 5 sarcomas. Hypernephromas and adenocarcinomas. Adenomas, carcinoma and papilloma. Some reported as angiosarcoma. (1 in 5000).
	Haaland.....	Mouse	300	2	0.66	
	McCoy.....	Rat	100,000	11	0.01	
	Wooley and Wharry..	Rat	23,000	3	0.01	
	McCoy.....	Squirrel	250,000	8	0.003	
	Curtis.....	Bird	880	5	0.5	
	Burger.....	Bird	852	0	0.0	
	Kimura.....	Horse	77,224	9	0.01	
	Trotter.....	Cattle	305	1	0.32	
	Sticker.....	Cat	21	0	0.0	
	Roffo.....	Cat	7	0	0.0	
	Murphy.....	Cat	11	0	0.0	
	Slye.....	Mouse	33,000	16	0.04	
			487,000	107	0.02	
			Number of tumors			
Relative frequency among tumors in general in animals	Sticker.....	Swine	12	7	58.3	Most of mixed type. All hypernephroma. Tumors benign adenomas resembling Wilm's tumor. (1 in 50).
	Chicago Lab.	Hogs	93	52	55.8	
	Tyzzar.....	Mouse	83	4	4.8	
	McCoy.....	Rat	103	11	10.6	
	Wooley and Wharry..	Rat	22	3	13.6	
	Curtis.....	Bird	79	5	6.3	
	Wernicke.....	Bird	34	3	8.8	
	Burger.....	Bird	12	0	0.0	
	Joest and Ernesti....	Bird	163	0	0.0	
	Scott.....	Rabbit	39	5	12.8	
	Sticker.....	Horse	509	37	7.2	
	Sticker.....	Cattle	78	10	12.8	
	Sticker.....	Dog	766	19	2.4	
	Slye.....	Mouse	5,000	16	0.3	
			6,992	172	2.4	

0.02 per cent. (1 in 5000). The hog, however, which is the only animal having kidney tumors similar to those in children, shows an incidence which is much higher; thus, in statistics from the Chicago Laboratory of the Bureau of Animal Industry, 52 kidney tumors in hogs were found in 2000 specimens of all animals (2.6 per cent.). Mixer, in 12 years, found but 27 kidney tumors in the Boston Children's Hospital and his personal practice. Loughnane found but 35 cases in London hospitals during 12 years; however, in reviewing the statistics of the Registrar General of Great Britain for the

same period, he found 557 deaths from "cancer of kidney and suprarenal capsule" under the age of fifteen years. Squier, in 324 adult surgical kidneys, found 24 tumors (7.3 per cent.).

The relative frequency of kidney tumors among tumors in general is 0.5 per cent. (1 in 200) for adults. Wood has put it as high as 2 per cent. In children it is very much greater—20.4 per cent. (1 in 5). This is borne out by the figures of D'Espine and Piso (Porter and Carter), who found the following proportion in 393 cases of tumor in children: eye and orbital structures, 52 per cent.; kidney, 20 per cent.; bone, 17 per cent.; brain, 5 per cent.; abdomen and pelvis, 4 per cent. In animals this proportional frequency is much less—2.4 per cent. (1 in 50).

Analysis of our tables as to the relative proportion of children to adults shows it to be 24 per cent. (1 to 4). Rohrer (Wood) is quoted as stating that one-third of all kidney tumors occur in children.

Comparison of the relative frequency of the mixed tumors to the hypernephroma shows that the former constitute about 9.1 per cent. and the latter 36 per cent. of all kidney tumors. The figure for hypernephroma is probably a little low, 60–80 per cent. being more correct. Of interest here are Albarran and Imbert's figures which show in children the preponderance of the mixed tumor and very few hypernephromata and vice versa in adults. They found in children 49 mixed tumors and 5 hypernephromata as against 10 mixed tumors and 85 hypernephromata in adults. This is in accord with the general opinion that mixed tumors are the renal tumors of infancy and childhood and the hypernephroma of adult life.

As to the side affected we find that both sides are attacked with about equal readiness. Thus, in 520 cases in children, we find that the right side was

TABLE III.
Occurrence of Mixed Tumors of Kidney in Children as to Side.

	Author	Number of cases	Right	Left	Bilateral	Not stated
Relative frequency as to sides (children)	Loughnane.....	35	17	13	1	4
	Willan.....	59	26	31	0	2
	Walker.....	141	58	73	10	..
	Binney.....	27	13	14	..	..
	Watson.....	100	37	41	6	16
	Albarran and Imbert....	138	65	69	4	..
	Total.....	520	216	241	21 (4%)	22

involved 216 times, the left 241 and 22 not stated (Table III). In this figure 21 (4 per cent.) were bilateral. Isolated cases of bilateral involvement may be occasionally found in the literature. Van der Byl reported a case in which a nephrectomy had been performed for a malignant kidney tumor; 4½ years later the remaining kidney developed a "sarcoma." In Strong's case a kidney tumor weighing 2½ pounds was removed. The child died one month later and autopsy revealed an 8-pound tumor of the other kidney. Steadman in 1881 reported a case of bilateral tumors in a four-year-old

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girl. Of interest also is J. W. Wood's case; autopsy on a three months' female child revealed the absence of the right kidney while the left kidney contained "a cancerous growth" 5 inches long and 3 inches in breadth. Other cases of bilateral involvement have been reported (Fraser, Napier). Analysis of statistics gathered from the literature shows the involvement of sex to be equal; thus, in 1037 cases, there were 500 males, 500 females and 37 not stated (Table IV). Analysis of collected statistics as illustrated by the accompanying chart show that the embryonic mixed tumors are the kidney growths in childhood

TABLE IV.
Occurrence of Mixed Tumors in Kidneys of Children as to Sex.

Relative frequency as to sex in children	Author	Number of cases	Male	Female	Not stated
	Loughnane.....	557	272	285	..
	Kelynack.....	66	30	36	..
	Binney.....	31	9	17	5
	Hyman.....	8	3	5	..
	Walker.....	130	55	51	24
	Albarran and Imbert.....	138	80	55	3
	Watson.....	100	50	45	5
	McCarty.....	7	1	6	..
	Total.....	1,037	500	500	37

(Fig. 9). Note that the peak is reached in the first 5 years of life. Comparison has been made with the hypernephroma which is the most common occurring kidney tumor and is the malignancy in adult life after the fourth decade. Rohrer (Kelley, J. T.) claims that one-third of all cases of primary renal growths occur in children; of 115 cases he found that 37 occurred before the age of 10 years, 31 cases being in children before the age of five years. Steffen in 219 cases found that 168 occurred in the first five years. Walker, analyzing 142 cases, noted 116 during the first 5 years. Hyman, in analyzing the literature, found that in 165 cases, 131 were found within the first 6 years. Taylor in collected statistics found 106 of 130 cases as occurring during the first 5 years and of these 57 were in the first 2 years. Loughnane, in the 557 cases from the Registrar General, found that 430 died in the first 5 years and 127 from 5 to 15 years. Binney, Albarran and Imbert, Wood and others, all substantiate the fact that the major number of cases occur within the first 5 years. These tumors may also occur at birth. Jacobi in 55 collected cases found 5 to be congenital. Paul found 2 in stillbirths. Rare cases in which the tumor has been of sufficient size to obstruct labor have been reported (Porter and Carter). From the chart it is at once apparent that mixed tumors occur essentially during early childhood. Hence it may be seen that these tumors are quite rare after the age of 15 years. Hence it may be

Clinical Picture.—The symptomatology as presented in children is practically opposite to that in adults. The senior author in a previous publication *

* Hinman: Early Diagnosis of Renal Tumor. Surg., Gyn. and Obs., 1917, vol. xxiv, p. 669.

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	Albarran and Imbert....	138	65	69	4	..
	Total.....	520	216	241	21 (4%)	22

involved 216 times, the left 241 and 22 not stated (Table III). In this figure 21 (4 per cent.) were bilateral. Isolated cases of bilateral involvement may be occasionally found in the literature. Van der Byl reported a case in which a nephrectomy had been performed for a malignant kidney tumor; 4½ years later the remaining kidney developed a "sarcoma." In Strong's case a kidney tumor weighing 2½ pounds was removed. The child died one month later and autopsy revealed an 8-pound tumor of the other kidney. Steadman in 1881 reported a case of bilateral tumors in a four-year-old

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girl. Of interest also is J. W. Wood's case; autopsy on a three months' female child revealed the absence of the right kidney while the left kidney contained "a cancerous growth" 5 inches long and 3 inches in breadth. Other cases of bilateral involvement have been reported (Fraser, Napier).

Analysis of statistics gathered from the literature shows the involvement of sex to be equal; thus, in 1037 cases, there were 500 males, 500 females and 37 not stated (Table IV).

Analysis of collected statistics as illustrated by the accompanying chart show that the embryonic mixed tumors are the kidney growths in childhood

TABLE IV.
Occurrence of Mixed Tumors in Kidneys of Children as to Sex.

	Author	Number of cases	Male	Female	Not stated
Relative frequency as to sex in children	Loughnane.....	557	272	285	..
	Kelynack.....	66	30	36	..
	Binney.....	31	9	17	5
	Hyman.....	8	3	5	..
	Walker.....	130	55	51	24
	Albarran and Imbert.....	138	80	55	3
	Watson.....	100	50	45	5
	McCarty.....	7	1	6	..
	Total.....	1,037	500	500	37

(Fig. 9). Note that the peak is reached in the first 5 years of life. Comparison has been made with the hypernephroma which is the most common occurring kidney tumor and is the malignancy in adult life after the fourth decade. Rohrer (Kelley, J. T.) claims that one-third of all cases of primary renal growths occur in children; of 115 cases he found that 37 occurred before the age of 10 years, 31 cases being in children before the age of five years. Steffen in 219 cases found that 168 occurred in the first five years. Walker, analyzing 142 cases, noted 116 during the first 5 years. Hyman, in analyzing the literature, found that in 165 cases, 131 were found within the first 6 years. Taylor in collected statistics found 106 of 130 cases as occurring during the first 5 years and of these 57 were in the first 2 years. Loughnane, in the 557 cases from the Registrar General, found that 430 died in the first 5 years and 127 from 5 to 15 years. Binney, Albarran and Imbert, Wood and others, all substantiate the fact that the major number of cases occur within the first 5 years. These tumors may also occur at birth. Jacobi in 55 collected cases found 5 to be congenital. Paul found 2 in stillbirths. Rare cases in which the tumor has been of sufficient size to obstruct labor have been reported (Porter and Carter). From the chart it is at once apparent that mixed tumors are quite rare after the age of 15 years. Hence it may be seen that these tumors occur essentially during early childhood.

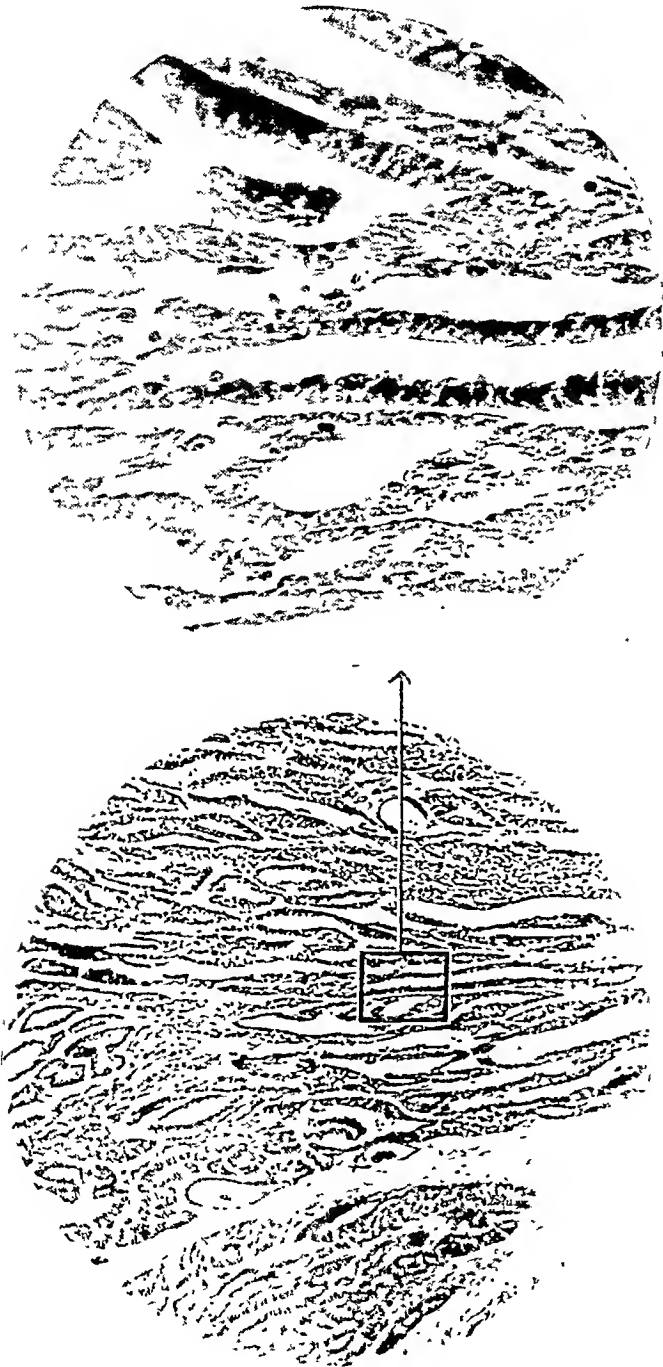
Clinical Picture.—The symptomatology as presented in children is practically opposite to that in adults. The senior author in a previous publication *

* Hinman: Early Diagnosis of Renal Tumor. Surg., Gyn. and Obs., 1917, vol. xxiv, p. 669.

has shown that in adults, hæmaturia occurs as an initial symptom on the average in about 42 per cent. of cases and pain in 32 per cent. and tumor in 18 per cent. Eisendrath has noted that the three symptoms associated

in various combinations occur in 78 to 80 per cent. of adult cases; that tumor but rarely was an initial symptom. In children the symptomatology is reversed and has a most insidious onset. The child may be perfectly healthy and well nourished at first. Tumor is nearly always the initial symptom. Occasionally diarrhœa, gastro-intestinal disturbances and emaciation may call attention to the presence of a tumor but only after physical examination. These tumors are painless as evidenced by the lack of complaints on the part of children. If present, it is usually of the dull aching type due to pressure on the intercostal or lumbar nerves. Colicky pain has occurred

FIG. 5.—Microphotographs (low and high power) showing the embryonic tubular formation of the tumor. The cell types approach very closely those found in the embryonic renal blastema.



when due to the passing of a clot down the ureter. The growth of the tumor at first is slow but soon becomes rapid, so that it is not uncommon to see them assume large proportions in a period of weeks. It is during this period that

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Fraser has suggested that the tumor changes from a slow growing adenomatous type to the rapidly growing sarcomatous type. If allowed to go on the tumor becomes of such immensity as to interfere with the normal functions of life.

Hæmaturia but very rarely is the initial symptom and is of rare occurrence at any stage of the disease. Walker in a series of 90 cases found tumor to be the initial symptom in 38 cases (42 per cent.); pain in 14 cases (15 per cent.); general weakness in 10 cases (11 per cent.); vomiting in 8 cases (8.8 per cent.); icterus in 2 cases (2.2 per cent.); diarrhoea, constipation, ascites and cough, one each.

Albarran and Imbert noted tumor as an initial symptom in 71 per cent., pain in 20 per cent. and hæmaturia in only 5 per cent. Imbert found pain the initial symptom in 20 per cent., while Watson found it in 7 per cent., it being present at some time of the disease in 20 per cent.; in 9 per cent. it was noted that no pain was present at any time. Mixter, also, found hæmaturia but twice in 27 cases and microscopically in 6. Fraser reports a case in which there was a short period

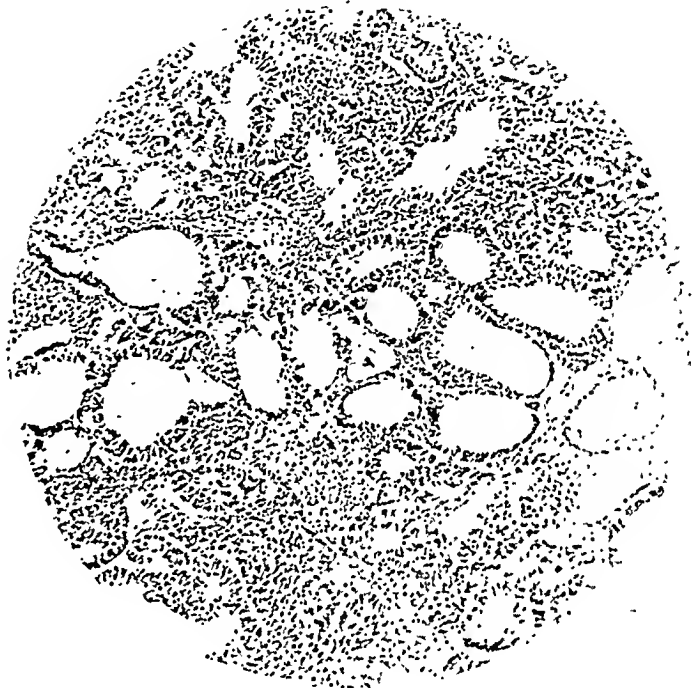


FIG. 6.—Microphotograph (low power) of a more cellular part of the tumor. It is characteristic of an embryonal adeno-carcinoma of renal blastema.

of hæmaturia about one year before the presence of tumor. Monsarrat does not believe that hæmaturia is as rare as is generally believed. He quotes Walker's 42 per cent. and presents a collected series of cases in which hæmaturia was mentioned; he found it to be present in 11 cases (35 per cent.) and absent in 20 cases. The fact nevertheless has been borne out by the majority of authors that it is very rare as an initial symptom and rather uncommon at any stage of the disease.

In the later stages of the disease the tumor is found growing to immense proportions. Associated with it are the signs of malignancy—anæmia, emaciation and general weakness. Signs of intra-abdominal pressure are seen in the swelling of the lower limbs, ascites, gastro-intestinal disturbances and enlargement of the superficial abdominal veins. In the very large cases diastasis of the recti muscles has been noted, with dyspnœa, cyanosis and pleural effusion where the thoracic cavity has been encroached upon.

The course of the disease is a very rapid one, the patient usually succumb-

Signs and Symptoms of Malignant Tumor of the Kidney in Children

	Initial %	Associated %
Tumor	42-71 Ave. 57	90
Pain	7-20 Ave. 14	20
General weakness	11	
Vomiting	8.8	
Icterus	2.2	
Diarrhœa, constipation, ascites ...	1 each	
Hæmaturia	Rare	5-35 Ave. 14

Note the reverse in the "Cardinal Trio" of symptoms from adults.

ing within a period of one year. Death is usually due to severe cachexia and occasionally metastases unless an intercurrent infection has not set in.

These tumors do not metastasize to the extent that other kidney tumors do. Walker found that in 142 mixed tumors metastases occurred in 55 (38 per cent.) to the following organs:

	Cases		Cases
Liver and lungs	11	Liver	4
Opposite kidney	11	Portal vein	1
Retroperitoneal glands	10	Diaphragm	1
Mesenteric glands	6	Scrotum	1
Vena cava	6	Bladder	1
Pleura	3		

Small intestines, colon and adrenals were also involved by direct extension.

Watson found metastases in 21 per cent. and in the following organs:

	Cases		Cases
Lungs	9	Vena cava	2
Liver	7	Axillary glands	1
Peritoneum	5	Bowel	2
Dura mater	1	Retroperitoneal glands	2
Scrotum	1	Mediastinal glands	1
Iliac fossa	1	Mesentery	1

From these tables it is apparent that when metastases occur they do so chiefly through the blood channels, involving the lungs and liver most usually and to an equal degree.

Diagnosis.—The attempt to make an early diagnosis in this disease is a difficult one for various reasons. The onset is usually insidious and one without any premonitory symptoms. As has been pointed out, tumor is usually the first symptom. The abdomen in infants and young children is quite apt to be somewhat protuberant, thereby tending to mask any early manifestation of the tumor. At this stage it may only be discovered by accidental palpation of the abdomen. Usually it is too late when the tumor can be palpated. Porter and Carter have called attention to the early appearance of a fullness at the costovertebral angle of the affected side. Gentle ballottement at the

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costovertebral space is of importance. The firm but gentle intermittent pressure of the finger tips applied here will usually sense any of these enlargements.

The urine usually shows but little. Hæmaturia is not a feature. Pyuria associated with albumin and casts has been found at times, while it is not unusual to have practically negative findings as in our case.

Cachexia and anorexia are important signs but occur too late. Fever has been found in many of these cases.

That diagnosis of the urinary tract in children can be put upon a sounder basis by complete urological investigation has already been shown in previous publications.[†] The information received from differential kidney studies, microscopically and functionally, as well as by pyelography yields valuable data. That this can be carried out in the very young is well illustrated in Deming's case. The accompanying illustrations (Fig. 15) show the type of renal pelvic deformities associated with the mixed type of tumor.



FIG 7—Microphotograph (high power) of tumor showing the structure of the tubular elements. Compare with Fig. 8.

In some respects it is not unlike those found in the adult, namely, the process is one of encroachment upon the renal pelvis. The contour of the pelvis may have been completely destroyed and marked deformity or displacement of the ureter have occurred as is shown in our case.

The presence of a large tumor in the lumbar region in childhood, especially if of rapid growth and associated with anæmia and cachexia, should always make one suspicious of a renal tumor. It usually begins in a lateral position. Air injection of the colon may be of considerable help in determining the position of the tumor.

There are several other conditions that present themselves for differential diagnosis. Mixer has called attention to a class of perirenal growths, the neurocytoma or neuroblastoma, which are considered as being derived from adrenal rests. He found 5 in his series of 27 cases. They can only be differentiated from the true kidney tumors by certain characteristics of the

[†] Hinman, F.: The Cystoscopic Study of Urologic Conditions in Children. *Am. Jour. Dis. Children*, 1919, vol. xvii, p. 305. Multiple Renal and Ureteral Stones in an Infant of Eleven Months. *J. A. M. A.*, 1921, vol. lxxvi, p. 237.

metastases. There is the one type which metastasizes most rapidly and diffusely and yet the primary growth may be so small as to be overlooked. A case is cited in a two months' old child (Mixer) in whom there were multiple tumors of the buttocks, liver and forehead while the primary tumor in the adrenal was only the size of a walnut and only demonstrated at autopsy. The other type of neurocytoma grows to a large size without any evidence of metastases and cannot be differentiated clinically from the mixed tumor of the kidney except by direct pathological examination.

New growths of the retroperitoneal glands may occasionally cause confusion. Kidney tumors appear more laterally placed while the glands may be more central in position with an area of surrounding resonance.

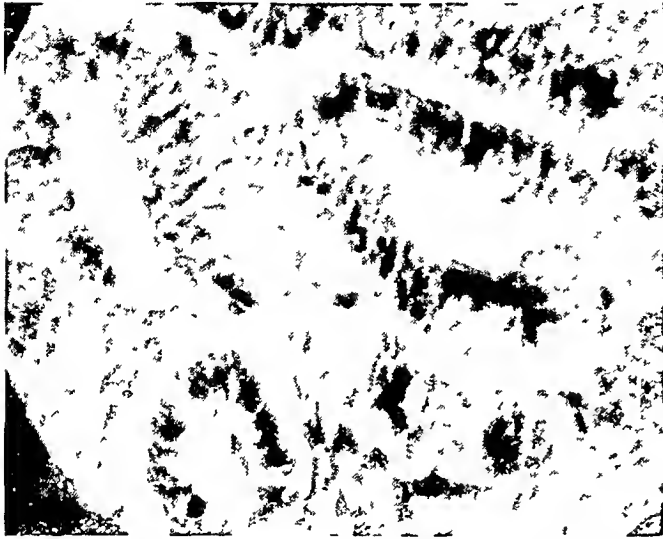


FIG. 8 —Microphotograph (high power) of the tubular elements in the embryonic kidney of a 20 mm. human foetus. Compare with Fig 7.

Splenic enlargements are encountered. These are usually due to the various leukæmias, malaria or lues. Careful blood studies are therefore essential. The anterior border of the spleen is sharp and there is usually no resonance over its anterior surface.

Inflation of the large bowel may help in ruling it out. Splenic tumors also may have an area of resonance between the medial border of the tumor and the spinal column.

Tumors of the liver in children are exceedingly rare. Even the presence of jaundice may not be a point of differentiation since it must not be forgotten that the kidney tumors may grow to such proportions as to obstruct the bile ducts. The anterior border of liver tumors is easily felt and quite distinctive.

Hydronephrosis is of rare occurrence in children. It is slow in its development and never reaches the size of kidney tumors.

Renal tuberculosis does not reach the size of these tumors and presents usually characteristic urinary findings.

Tuberculous peritonitis may offer some difficulty but it can be ruled out by general signs and symptoms of the disease as well as a suggestive history, and the characteristic elongated tumor mass in the abdomen in transverse position.

Ovarian conditions and Wolffian body cysts are too rare for serious consideration.

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Prognosis and Treatment.—The treatment for mixed tumors of the kidney is early radical excision. We will not enter into the relative advantages of either the abdominal or lumbar route. Albarran and Imbert found in 101 cases that their mortalities were: abdominal route 26 per cent.; lumbar route, 28 per cent. That these operations can be performed in very young patients under local anæsthesia has been shown (Deming).

The prognosis of this disease is indeed a very dark one. The primary mortality from operation with that due to recurrences is very high, it having been placed by some as high as 93 per cent.

Albarran and Imbert in analyzing statistics between 1876 and 1902 found

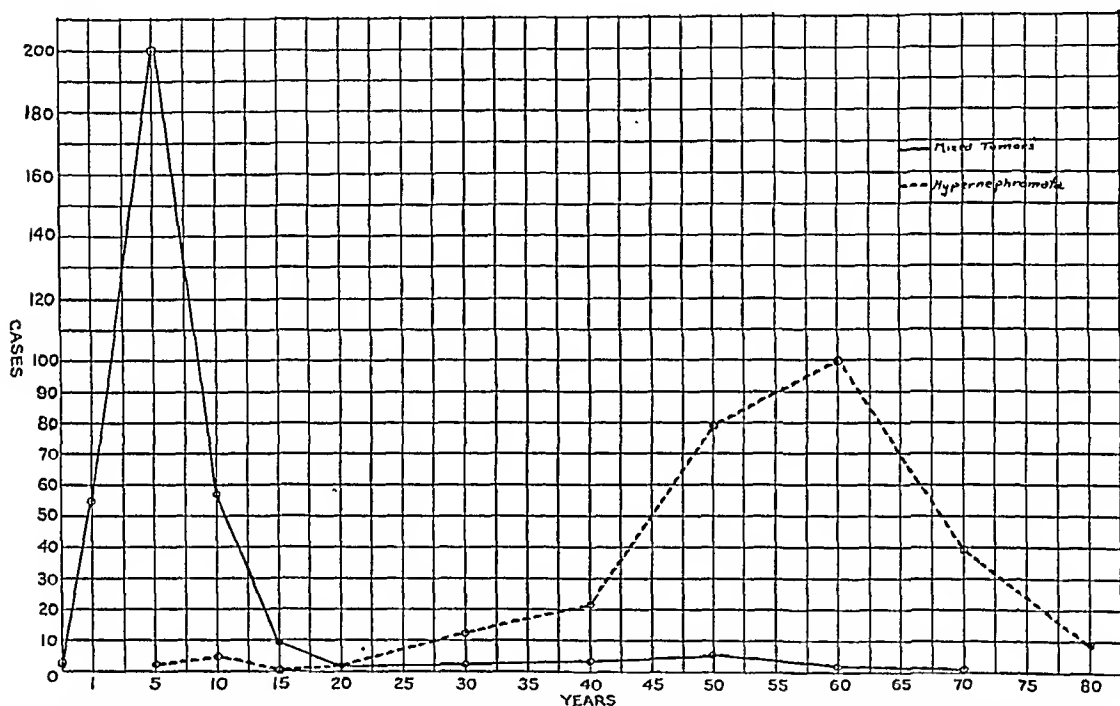


FIG. 9.—Chart showing age incidence of "mixed tumors" and hypernephromata of the kidney. Note that the "mixed tumors" occur chiefly in childhood and hypernephromata in old age. Based on 341 "mixed tumors" and 267 hypernephromata.

that the operative mortality dropped from 52 per cent. to 21–25 per cent. It seems never to have gotten less than this except in isolated series and usually is higher. The following are a few quoted from the literature: Walker, 36.4 per cent. in 74 cases; Lewi (Monsarrat), 28 per cent. in 62 cases; Albarran, 30 per cent. in 97 cases; Heresco (Monsarrat), 17 per cent. in 53 cases; Shannon, 38 per cent.; Concetti (Jacobi), 40 per cent.; Hyman, 12½ per cent. in 8 cases; Loughnane, 8 per cent. in 13 cases; Mixter, 35 per cent. in 14 nephrectomies and 44 per cent. in 9 explorations. The general average is 28.5 per cent. This high primary mortality must undoubtedly be due to the poor condition these patients are in at the time of operation. Monsarrat, in his collected series, has pointed out that the younger patients seem to tolerate operation somewhat better; thus, of 23 cases that were under two years of age, 4 died (17 per cent.).

The rate of recurrence in the surviving cases is very high. In Monsarrat's series of 104 collected cases 77 (74 per cent.) survived operation; of these only 58 have had

any follow-up; of these, 40 (51 per cent.) died within a few months, leaving 18 (23 per cent.) living and well on the average of $8\frac{1}{2}$ months post-operative. Concetti (Jacobi) found that of the 60 per cent. surviving operation, 45 per cent. died with recurrences. Loughnane in 35 cases collected from London hospitals found recurrences in 80 per cent., 70 per cent. of which occurred within one year. Hyman, in 7 cases (out of 8) surviving operation found that 5 died within 1 year, 4 of which occurred during the first 6 months. In Mixter's 9 surviving cases (out of 14) all except one died of recurrence in from 4 months to $1\frac{1}{2}$ years. From these statistics it is at once apparent that the ultimate mortality of this very malignant disease is between 80 and 90 per cent. Shannon states that the ultimate mortality is 94 per cent. and 5 per cent. cures. Concetti places the cures at 7 per cent. Bland-Sutton puts it at 5 per cent. It has been pointed out that the very



FIG. 10.—Drawings showing pelvic deformities of "mixed tumors" of the kidney in children as demonstrated by pyelography.

young patients, especially if under the age of two years, usually survive if they live one year or longer post-operative. There are some cures on record (Mixter, Hyman, Malcolm (Bland-Sutton), Abbe, etc.). Of these the most interesting is that of Abbe's. A $7\frac{1}{2}$ pound solid tumor (pathological report—"rhabdomyosarcoma") was removed by partial nephrectomy from a twelve months' child in 1892. The patient was reported as living and well and demonstrated to the New York Surgical Society in 1912—20 years since the operation.

No systematic study of the effect of the Röntgen-ray on these mixed tumors of the kidney appears in the literature. Friedlander in 1916 tried this method of treatment upon a four-year-old child with an inoperable tumor of the kidney. After seven treatments in seven to ten-day intervals the tumor decreased markedly in size and the child gained in weight and strength. A few months later it was noted that the patient was again becoming listless and the tumor larger. The patient contracted measles and died with a bronchopneumonia. Grisanti very recently reported a case in an eleven-year-old girl who at operation revealed a kidney tumor (sarcoma) so adherent as to make its removal impossible. The organ was brought to the surface and given thorough Röntgen-ray treatment at two sittings, through the laparotomy incision and a third after it had healed. By the end of the second month no tumor could be felt. It may possibly be that the course in the case may be similar to that of Friedlander's case just cited. Mixter and, more recently,

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Gage and Adams, have tried the Röntgen-ray on cases with post-operative recurrences but without avail.

In the treatment of these very malignant tumors we come against a peculiar paradox. The disease is one with an insidious onset, producing difficulties for an early diagnosis and yet to have a chance to cure, the diagnosis must be made very early and the extirpation complete.

Summary.—(1) The occurrence of renal tumor in children is 0.06 per cent. (1 in 1600); in adults 0.25 per cent. (1 in 400); in animals it has been found to average 0.02 per cent. (1 in 5000). The relative frequency of kidney tumors among tumors in general in children is 20.4 per cent. (1 in 5); in adults from 0.5 per cent. to 2 per cent.

The relative proportion of children to adults is 24 per cent. (1:4). It has been quoted as high as $33\frac{1}{3}$ per cent. (Rohrer).

The relative frequency of mixed tumors and hypernephroma in general is 9.1 per cent. and 36 per cent., respectively, 60–80 per cent. being more correct for the latter.

Involvement as to side and sex is about equal; 4 per cent. are bilateral.

(2) Mixed tumors of the kidney are the renal growths of childhood, the greatest majority occurring within the first five years; but they may occur later in life or be present at birth.

(3) Three theories have been put forth as to pathogenesis: (a) that they are due to inclusions of the Wolffian body (Birch-Hirschfeld); (b) that aberrant cells from the myotome, sclerotome and mesenchyma are the explanatory factors (Wilms); (c) that they are descendant from the true embryonic kidney tissue or renal blastema and develop by a process of metaplasia (Busse, Muus, Ewing).

(4) The tumors may assume large proportions, the average, however, being about 1 to 4 pounds. Grossly they appear as solid opaque or cystic processes. Microscopically various types of tissue are found—embryonic proliferating tissue, glandular, myxomatous, bone and cartilage, smooth and striated muscle fibres, etc. The picture usually presented, however, is an embryonic one, dominated by either glandular or cellular tissue; if the former it is called embryonal adenocarcinoma, if the latter, embryonal adenosarcoma.

(5) The clinical picture is presented in usually the following order—abdominal tumor; presence or absence of hæmaturia or pain; anæmia, general weakness, anorexia and cachexia terminally; metastases either local or distant. Tumor nearly always is the initial symptom.

(6) The routine urological procedure can be used to advantage in children.

(7) Differential diagnosis is from neurocytomata tumors of retroperitoneal glands, spleen enlargement, tumors of the liver, hydronephrosis, renal tuberculosis, tuberculous peritonitis and ovarian conditions.

(8) The prognosis is a very poor one, the ultimate mortality after nephrectomy ranging from 80 per cent. to 90 per cent.

(9) The treatment is early diagnosis and radical excision. The use of the Röntgen-ray has given but very little encouragement.

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PAPILLARY EPITHELIOMA OF KIDNEY PELVIS

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STIMULATED to increased interest in tumors of the kidney by Scholl's¹ recent article, it was our good fortune to recently diagnose a papillary carcinoma in the upper portion of the pelvis of the kidney prior to operation.

Due to the small number of cases reported in the literature, we desire to place the following case on record in order to better establish the diagnostic signs and symptoms. Up to the

present time fifty-one cases of papillary epithelioma of kidney pelvis have been reported, only thirteen of which were reported in American literature. Five of the American cases are from the Mayo Clinic.

No doubt the condition is much more common than the literature would indicate, as we know of three cases which have not been reported, namely: patients of C. E. Burford, of St. Louis, E. L. Keyes, of New York, and A. C. Gilbert, of Dallas, respectively. Those especially interested in the bibliography are referred to McCown's² article published in 1920.

Report of Case.—Register No. 2942; a deckhand, aged sixty-five years, white, married, Frenchman.

Entered hospital, March 4, 1924, complaining of passing blood from the bladder, weakness, and pain in the left lumbar region radiating to the left groin. He stated that the trouble started two years ago with an attack of pain in the left side and the passing of blood instead of urine; coming on apparently without cause. The present attack started two weeks ago with the passing of blood, followed by weakness and pain. No history of cough, night-sweats, passing of gravel or stomach trouble. *Family history.*—Negative. Wife in good health. Patient a hard worker. No alcoholics or drugs. Chews tobacco moderately. No history of any serious illness or injury. Denies any venereal disease.

Physical Examination.—Patient is a poorly nourished and muscled elderly white man; pale, worried expression; dyspnoeic upon slight exertion; weight 145 pounds.

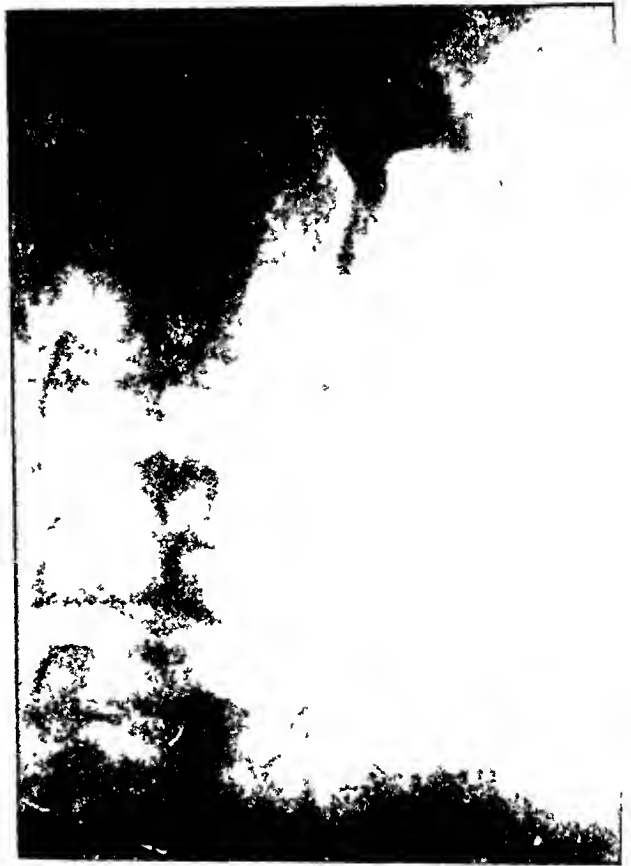


FIG. 1.—Pyelogram of left kidney; superior and middle calyces absent.

height 68 inches. Sclerae slightly injected; pupils large, react to light and accommodation. Tonsils red. Teeth poor and caries present. Thorax negative. Abdomen: No tumor masses palpable. Spleen, kidneys, and liver not palpable. Stomach tympany increased in size by percussion. Nervous system: Negative. Extremities: Normal. Genito-urinary system: No scars on penis. Testicles and epididymii normal. Prostate enlarged, hard, round.

Cystoscopic Examination.—March 8, 1924 instrument passed with ease. Bladder of good capacity; found filled with bloody urine. Sphincter margin slightly irregular;

trigone elevated; bladder wall showed many trabeculations. There was no evidence of papillomatous growths or tumors. The right ureteral orifice was small and pale. Ureteral catheter passed with difficulty due to spasm. spurts of blood were seen to come from the left ureteral orifice. Left ureter catheterized with ease. Specimens of urine collected. Pelvi injected with 20 per cent solution of sodium bromide and roentgenograms taken. Laboratory reported catheterized urine from the right kidney, negative. Left kidney, red blood cells many. No pus. Staphylo-



FIG 2 —Kidney split open after removal showing growth.

cocci on culture (probably contamination, in absence of pus). Pyelogram of the left kidney (Fig. 1) shows absence of the superior and middle calyces and upper portion of the pelvis. The inferior calyx is normal, showing the minor calyces.

March 14, 1924.—Patient complains of increase of pain in the left costo-vertebral angle, and the urine, which has been bloody continuously since admission, is entirely clear. This demonstrated very nicely the complete obstruction of the left ureter by blood clot.

March 15, 1924.—Cystoscopic examination was repeated March 15 to determine the function of the right kidney. This examination revealed a ropy blood clot, which was an exact mold of the ureter and was about 6 cm. in length protruding from the left ureteral orifice and curled within the bladder. No urine was seen to flow from this occluded ureter and the peristaltic waves were absent. A large Garceau catheter was inserted into the right ureter and 1 c.c. phenolsulphonthalein injected intravenously. The dye from the right ureter appeared in $4\frac{1}{2}$ minutes. It excreted 25 per cent. for first fifteen minutes 20 per cent. for second fifteen minutes. The bladder urine collected after one-half hour showed no dye because left ureter was occluded by blood clot.

PAPILLARY EPITHELIOMA OF KIDNEY PELVIS

March 25, 1924.—A diagnosis of papillary epithelioma of the left renal pelvis was made. Nephrectomy by Doctor Jones. Usual Mayo incision exposing left kidney. Fatty capsule somewhat adherent. Kidney delivered and split open exposing the growth. (Fig. 2). Pedicle doubly clamped; kidney removed and vessels ligated. Incision closed. Kidney was smaller than normal and the surface showed a hemorrhagic mottling. The ureter was apparently normal. The upper calyx was completely filled with a papillomatous growth.

Patient had an uneventful convalescence until evening of April 4, 1924 when he had a chill and his temperature jumped to 103.5° F. Cough and bloody expectoration and the left lower lobe showed definite involvement. After three or four days patient began to improve and went on to recovery. When discharged on May 12, 1924 he had gained 40 pounds. Blood count was normal. Patient stated that he felt perfectly well.

Microscopic examination of section of tumor growth reported by Dr. D. L. Harris, is as follows: The specimen consists of a sessile papillary out-growth from the upper pole of the pelvis of the kidney. Microscopic examination of sections show the growth to be made up of epithelial cells growing out upon branching connective tissue stalks. In the deeper lying portions the cells are elongated, but towards the surface they are oval or polyhedral. Mitotic figures are fairly numerous. Intra-cellular fibriles are easily seen in the cells near the surface. Diagnosis: Papillary carcinoma.

Laboratory Report.—March 19, 1924, red blood count 3,240,000, hæmoglobin, 65 per cent. May 7, 1924, (44 days after operation). Red blood count 4,200,000. Hæmoglobin, 75 per cent. White blood count 6480.

Blood Wassermann.—March 5, 1924: Positive double plus.

Blood Wassermann.—March 13, 1924: Positive plus.

Urine.—March 3, 1924: Alkaline gross blood; specific gravity, 1038. Albumin trace. Squamous epithelial cells present. Few granular casts.

Urine.—March 8, 1924: Albumen plus sugar absent. Granular casts present.

Urine.—March 20, 1924: Albumen plus. Granular casts and few pus cells.

Urine.—April 8, 1924: Acid, specific gravity 1022. Albumin, sugar, casts, and pus cells absent.

Guinea pig injected with catheterized urine left kidney. Autopsy showed no evidence of tuberculosis.

Comment.—The chief diagnostic findings in the case were persistent hæmaturia with weakness and pain in the left lumbar region radiating to groin, the pyelogram showing a normal lower calyx and absence of the two upper calyces. (The return flow of the opaque solution alongside the catheter showed that sufficient fluid had been injected.)

Differential Diagnosis.—The absence of pus (in catheterized specimen) and bladder symptoms, and the absence of any destruction seen in the pyelogram excluded tuberculosis. A hypernephroma which is causing such marked bleeding can usually be palpated externally, and the pyelogram presents a spider-web-like appearance rather than a filling defect. Syphilis was considered because of the two plus Wassermann reactions, but the absence of other luetic lesions, the profuse bleeding, and the pyelogram was evidence against it. We consider the prognosis of this case favorable.

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SQUAMOUS-CELL TUMORS OF THE RENAL PELVIS*

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SQUAMOUS-CELL changes in the urinary tract, as in the mouth, gall-bladder and other organs, generally form in response to repeated mechanical trauma or to tedious infections. All parts of the urinary tract are subject to this proliferation of epithelium to a condition resembling skin. Cedercreutz, Dittle and Kaufmann describe its occurrence in both benign and malignant stages in the urethra; Albarran, Hallé, and Kretschmer in the bladder; and Kischensky, Scheel, Cumming, and others in the renal pelvis. In the urethra and bladder epithelial changes may follow years of recurrent infection and scar formations; for example, Judd operated on a case of squamous-cell tumor of the anterior urethra which had followed twenty years of urethral infection and instrumental manipulations. Trzebicky reported a case of squamous-cell carcinoma developing on a traumatic stricture of ten years duration. In two cases treated at the Mayo Clinic squamous-cell carcinoma of the bladder followed periods of cystitis which commenced with the trauma of childbirth, twenty-eight and twenty-nine years before. Morris reported a case of squamous-cell tumor of the lower end of the ureter which for many years had been the resting place of calculi. In the renal pelvis similar epidermoid changes occur. Small areas of hyalinization and squamous-cell changes are not infrequently seen in hydronephrotic sacs. More extensive epidermoid changes occur in cases of long-standing renal infection, either with or without stones, but long duration of infection is not essential in all cases, for these changes at times result in association with short periods of severe infection (Figs. 1 and 2). In one case, in a man aged twenty-six years, a nephrectomy was performed at the Mayo Clinic after only nine months of severe pyelonephritis. The renal pelvis contained a number of raised, wrinkled, grayish-white plaques, 1 to 2 cm. in diameter; histologic examination revealed squamous-cell changes. Orth, Beselin, Hallé, and Kretschmer, have all reported cases of leukoplakia associated with tuberculous pyelitis. Not all cases, however, are the result of infection or long-continued irritation. Wendel reports a case in which there was no inflammation. Leber notes a case in an infant of four months; similar changes were also noted in the infant's eye. Lecène, Klug and Grauhan attribute the formation of leukoplakia to developmental changes. Richey holds that metaplasia occurs both as a physiologic process and as a

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result of certain pathologic conditions, the latter involving repeated trauma to a tissue over an extended period of time.

Not infrequently in the renal pelvis, as in the urethra and bladder, the same factor which produces the metaplasia continues its action until malignant changes develop. Albarran holds that most squamous-cell growths are preceded by leukoplakia. Besenbruch reported squamous-cell carcinoma developing on a case of tuberculous pyelitis. Spiess considered nineteen of 136 cases collected by him as squamous-cell carcinomas; seventeen of forty-three cases of non-papillary tumors of the renal pelvis collected by Kretschmer were considered as epidermoid growth. The tissues adjacent to the malignancy often showed epidermoid changes. Aschner described a case of squamous-cell carcinoma arising at the ureteropelvic juncture in association with leukoplakia of the renal pelvis.

Symptoms.—Squamous-cell tumors of the renal pelvis are comparatively symptomless. When obstruction occurs, it is from a gradual slow occlusion and is almost painless, at times causing tremendous dilatation of

the kidney pelvis. In contrast to papillary tumors, the squamous-cell carcinomas rarely bleed. A similar slow, painless occlusion and pelvic distention occurs with squamous-cell growths of the ureter. In a case reported by Rundle a hydronephrosis of two and a half litres resulted from a squamous-cell epithelioma which blocked the lower ureter; there had been no pain or renal colic. Squamous-cell epitheliomas of the renal pelvis may have a long-standing, possibly premalignant history of trauma and infection, as occurs in squamous-cell growths of the urinary bladder. Oraison reports the case of a woman, aged fifty years, whose symptoms of renal trouble started with trauma



FIG. 1.—Leukoplakia of the pelvis of a markedly infected kidney. Area of epidermization is white, thickened and involves the whole pelvis.

at twenty-four. At operation a squamous-cell tumor of the renal pelvis was found.

Similar to infection and stone formation, tumor growth is often seen in abnormally developed, poorly drained kidneys. Cases of squamous-cell carcinoma associated with stone in horseshoe kidneys have been reported by Wulff and Primrose.

Pathology.—There are two types of squamous-cell tumors arising in the renal pelvis: in the first, the renal parenchyma is invaded early, the kidney is solid and compact, and the parenchymal tissue becomes completely replaced by carcinoma and irregular masses of fibrosis: in the second, the growth is confined to the renal pelvis, the kidney is extremely large and hydronephrotic

with a pressure atrophy of most of the renal tissue.

In the first type, the carcinoma at times extends to the pedicle and neighboring glands; the pelvis is thickened and fixed by the tumor growth, and the malignancy is not infrequently associated with stones. This same association of squamous-cell tumors and calculi holds true in other organs. Nicholson collected sixteen cases of squamous-cell carcinoma of the gall-bladder; fifteen had gall-stones. It is possible that in certain cases the development of the carcinoma of the renal pelvis may precede



FIG 2 —(Case A75112) Leucoplakia of the pelvis of the kidney

the formation of stone. Hallé maintains that the metaplasia does not result from the irritation of the stone, but that the epidermization and calculi both result from the same chronic inflammation. In the renal pelvis the stones are at times extremely large, and of the staghorn earthy-phosphate type. Kaufmann reported a case in which the stone weighed 93 gm. A similar case was noted by Oraison, in which the patient had attacks of renal colic for twenty-eight years; the stone weighed 107 gm. Wells and Kundrat also report cases of squamous-cell tumors associated with large branching stones. Of eleven collected cases considered by Wells as definite squamous-cell carcinomas, six had stones. The long duration of symptoms of calculi and infection in most cases indicates that the presence of stone precedes the development of carcinoma by many years. The malignant changes set in later, possibly as a result of long-continued trauma, either inflammatory, mechanical, or both. In an occasional case there is a definite increase in the severity of the symptoms, suggestive of the onset of malignancy. In 108 cases of associated renal calculi and malignancy, collected by Martin and Mertz,

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the symptoms of stone averaged nineteen years in duration; the symptoms suggestive of malignancy averaged about five months.

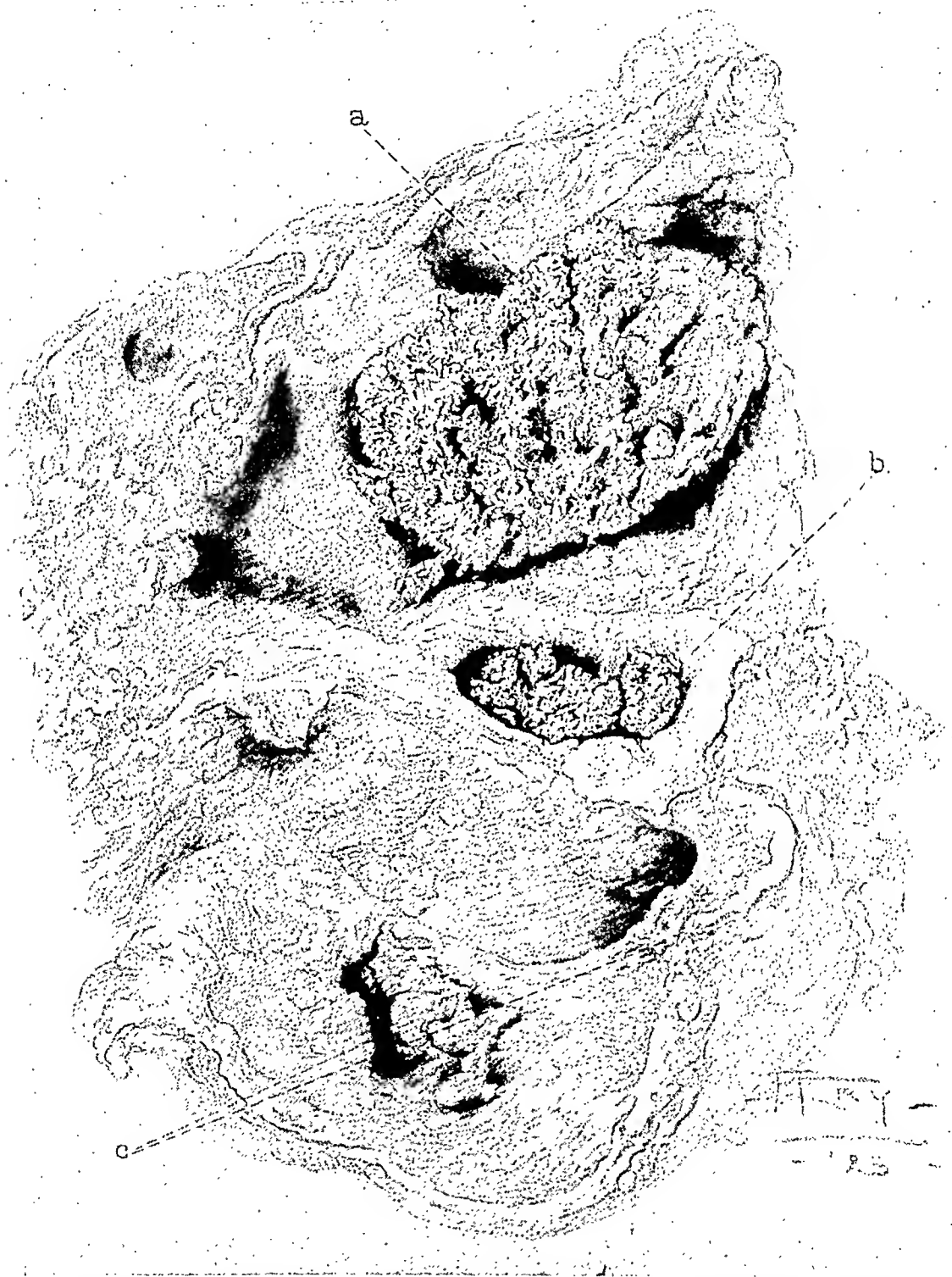


FIG. 3.—Portion of thickened sacculated pelvis of kidney, which is covered with papillomas and squamous-cell tumors. (a) and (b) grossly papillomatous masses, (c) flat tumors; all are composed of squamous-cell carcinoma.

The majority of stones found in cases of carcinoma of the renal pelvis are rough and irregular. Because of infection and ulceration of the pelvic mucosa, it is occasionally impossible to find any tissue adjacent to the pelvic wall suitable

for histologic examination. As the growth spreads throughout the kidney, the cells change to a more irregular, rapidly growing type and detach themselves from the original, identifying, epidermoid masses. In certain instances, the varying transition stages may be traced from a definite squamous-cell growth to masses containing only large irregular epithelial cells, loosely bound together, with little hyalinization or epithelial whorl formation. It is quite probable that the majority of the solid type of carcinomas of the kidney, the carcinoma simplex, occurring in association with infection and large pelvic stones, originate from metaplastic pelvic epithelium.

In the second type of squamous-cell carcinoma arising in the renal pelvis, there are numerous tumor masses on the thickened dilated

pelvic wall, some small and papillomatous, others large, bulky and at times smooth-surfaced. This type of growth causes comparatively few localizing symptoms. The insidious onset and lack of definite symptoms occurring with squamous-cell tumors of the urinary bladder also occur with this type



FIG. 4.—(Case A400589.) Hyalinization and squamous-cell formation from tumor of renal pelvis.



FIG. 5.—(Case A320171.) Extensive wedge of squamous-cell carcinoma with small area of hyalinization.

of growth in the renal pelvis. The ureter is occluded, and there is a complete atrophic destruction of the parenchymal tissue. Attention may only be directed to the condition by the finding of a large cystic abdominal mass. There is at times extreme hyalinization and epithelial desquamation of the type described by Rokitansky as cholesteatoma; Luys and Chenot and Ewing described cases of this type. In a few instances papillary tumors of a moderate degree of malignancy are found associated with squamous-cell lesions. The primary growth is possibly papil-

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papillary and squamous characteristics. Battle also describes squamous changes in a small villous growth, and Rohde, Scheel, and Menetrier and Martinez describe combinations of papilloma and squamous-cell epithelium.

Metastasis.—Metastasis occurs early and extensively in both types of squamous-cell growth. The cases reported by Kischensky, Menetrier and Martinez, Scheel and Ewing had metastasis to the liver, lungs and bones. In an occasional case extension occurs through the large blood-vessels similar to the mode of extension in adenocarcinomas (hypernephromas); Taddei noted an occlusion of the vena cava, the carcinoma having grown through the renal vein. In the case reported by

Wells the tumor had grown extensively into the perirenal tissues.

The metastatic growths are usually of epidermoid structure, even though the original growth contains both papillary and squamous-cell masses as in Scheel's case. The same extensive

metastasis also occurs in squamous-cell carcinoma of the ureter. In the bladder, metastasis occurs only rarely with epidermoid carcinomas; death usually results from the local condition before

extension occurs. As brought out by Braasch in regard to renal tumors in general, extensive metastases may be present when the renal growth is so small that it cannot be palpated clinically.

Prognosis.—Squamous-cell tumors of the renal pelvis offer the patient a very poor prognosis, and in this respect are comparable to histologically similar tumors occurring in the urinary bladder. Five of six patients with squamous-cell tumors of the urinary bladder examined at the Mayo Clinic died shortly after the disease had reached a stage requiring treatment. Because of the comparative absence of symptoms, treatment is generally not considered while the growth is still in the early stages. In a series of cases reported by Kretschmer, there were eight nephrectomies for squamous-cell carcinoma of the renal pelvis; five patients died at operation or shortly afterward, and the remaining three developed extensive metastasis not long after the operation.

Mayo Clinic Series.—From 1907 to 1922, five cases of squamous-cell tumor of the renal pelvis were treated at the Mayo Clinic.

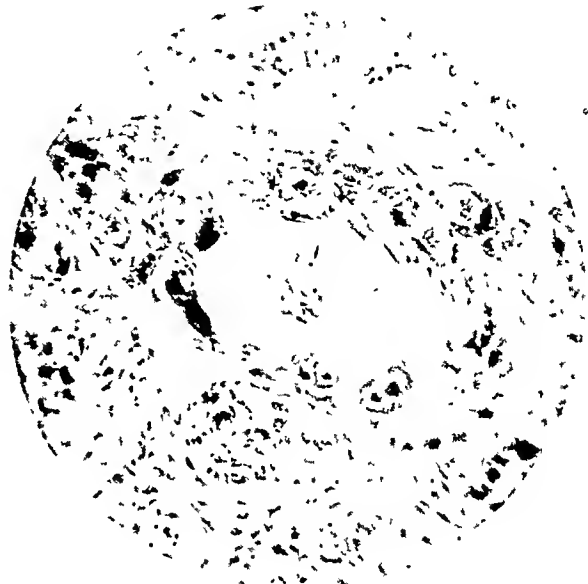


FIG. 6.—(Case A23253.) Epithelial pearl formation from squamous-cell carcinoma of the renal pelvis.

REPORT OF CASES

CASE I.—(A 400,589.) A man aged sixty-two years, came to the Clinic August 7, 1922, complaining of a tumor in the right side of the abdomen "about the size of his fist." This was first noticed four months prior to the patient's registration at the Clinic,

and had increased rapidly in size. For the past three years he had moderate frequency of urination. Eighteen months before, he had had a moderate intermittent hæmaturia, but none for the past year. He had not lost weight, and his general condition was good. On examination the mass was found to be very large, filling the right side of the abdomen; it was soft, rounded and painful on palpation. The urine was not abnormal, and the phenolsulphonephthalein return was 40 per cent.; the blood urea content and hæmoglobin were normal. Röntgenographic examination of the kidneys, ureters and bladder was negative. Cystoscopic examination revealed a normal bladder mucosa; there was hyper-

secretion from the left kidney; the right ureteral opening was small; no secretion was seen in ten minutes' observation, and an obstruction impassable to the ureteral catheter was found 20 cm. from the bladder.

At operation, through a transperitoneal incision, the tumor was found to be cystic and irregular, and firmly adherent to all the surrounding tissues. In freeing the adhesions the renal mass was ruptured, and the remaining shell then removed. The patient was in good condition at the end of the operation. The convalescence was uneventful, save for a reopening of the wound which was successfully resutured.

Pathology.—The renal mass was tremendously dilated and there was complete atrophy of the parenchymal tissue. The pelvis was greatly thickened, sacculated, and surfaced with many irregular tumors varying in size from 1 to 8 cm. in diameter. These tumors were of two types; some, especially the smaller ones,

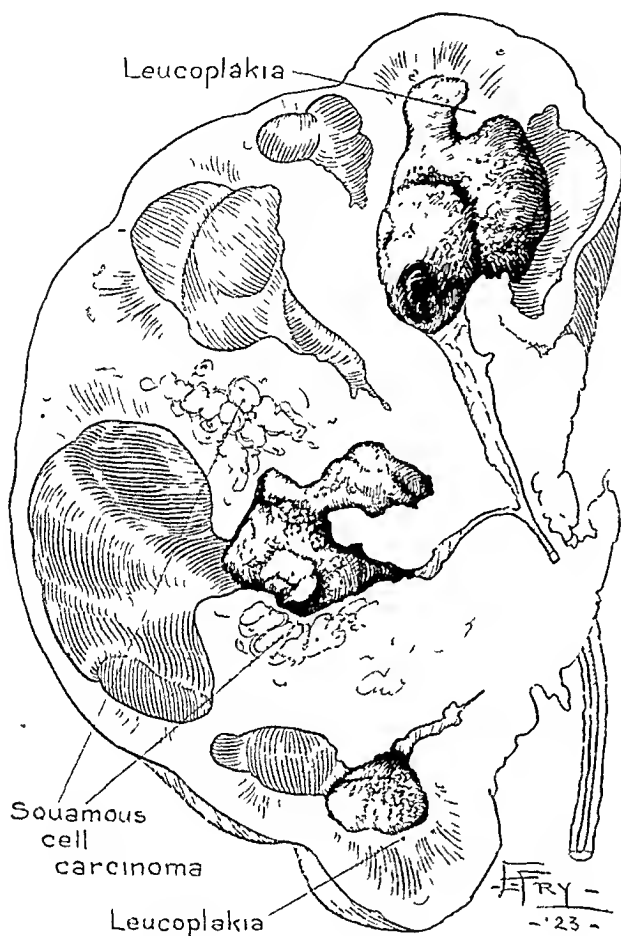


FIG. 7.—Squamous-cell tumor of the renal pelvis infiltrating entire kidney. Areas of leucoplakia surround fragments of stone.

were loose and papillomatous, others were hard and smooth-surfaced or covered with papillomatous protrusions, while the intervening mucosa in many areas was thickened, wrinkled and gray in color. There were a number of dilated pouches extending from the distended pelvis, and probably corresponding to the site of the original calices, some of which were from 6 to 8 cm. in diameter, and had the same wrinkled epidermoid appearance as the pelvis (Fig. 3). A number of irregularly rounded stones, about 1 cm. in diameter, were found loose in the pelvis. The solid masses were very friable, similar to the extensively hyalinized areas of squamous-cell growth occurring in the bladder. Histologically, the hard tumors were squamous-cell carcinoma of a high degree of malignancy (Fig. 4). There were extensive masses and large circular plugs of cells undergoing various stages of hyalinization and epithelial whorl formation. In many areas the cells were large,

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with clear-cut outlines, containing one or more deeply stained nucleoli. Many large, atypical mitotic figures were seen. The process was a much more rapid growth than is usually found in similar tumors located in the urinary bladder. In many areas remnants of altered papillæ and the cellular arrangement indicated the probable papillary origin, and this was much more evident in the grossly papillomatous type of growth. In no area was the growth found to penetrate through the pelvis, but the uninvolved mucosa of the pelvis and calices in many areas was undergoing definite epidermoid changes.

CASE II.—(A320,171.) Mrs. H. B. S., aged fifty-three years, came to the Clinic June 16, 1920, complaining of attacks of moderate abdominal pain, which had started nine months before. There was no nausea or vomiting, and at the onset the pain was on the right side; recently it had become more severe and localized in the lower abdomen. An appendectomy had been performed without relief.

The general physical examination was negative; the urine was not abnormal; the hæmoglobin was 67 per cent.; the phthalein return, 55 per cent. A röntgenogram of the urinary tract contained several indefinite shadows in the right kidney region. Cystoscopic examination revealed a chronic diffuse cystitis; the left ureteral opening was normal, and the secretion normal and clear; the right opening did not contract and the ureteral catheter met an impassable obstruction 20 cm. from the bladder; urine from the right ureter contained pus, and a pyelogram of this side revealed a rough irregular pelvic outline.

June 22, 1920, a large, solid, firmly adherent kidney was removed through a right lateral incision, and extensive induration and œdema around the hilus was found to be present. The pedicle was not tied on account of the friability of the tissues; five forceps were clamped and left in place. The patient rallied well from the operation and the forceps were removed on the fifth day. On the eighth day she felt weak, had a subnormal temperature and gradually declined, dying on the eleventh day.

Pathology.—The kidney was about twice normal size, solid and fibrous, imparting a gritty sensation to the knife. On cut section the surface was board-like, with many interlacing bands of fibrous tissue throughout. The pelvis was fixed, and surrounded by solid malignant and fibrous tissues; it had an extensively desquamating surface from which bands of white radiated out into the surrounding mass. There was also an

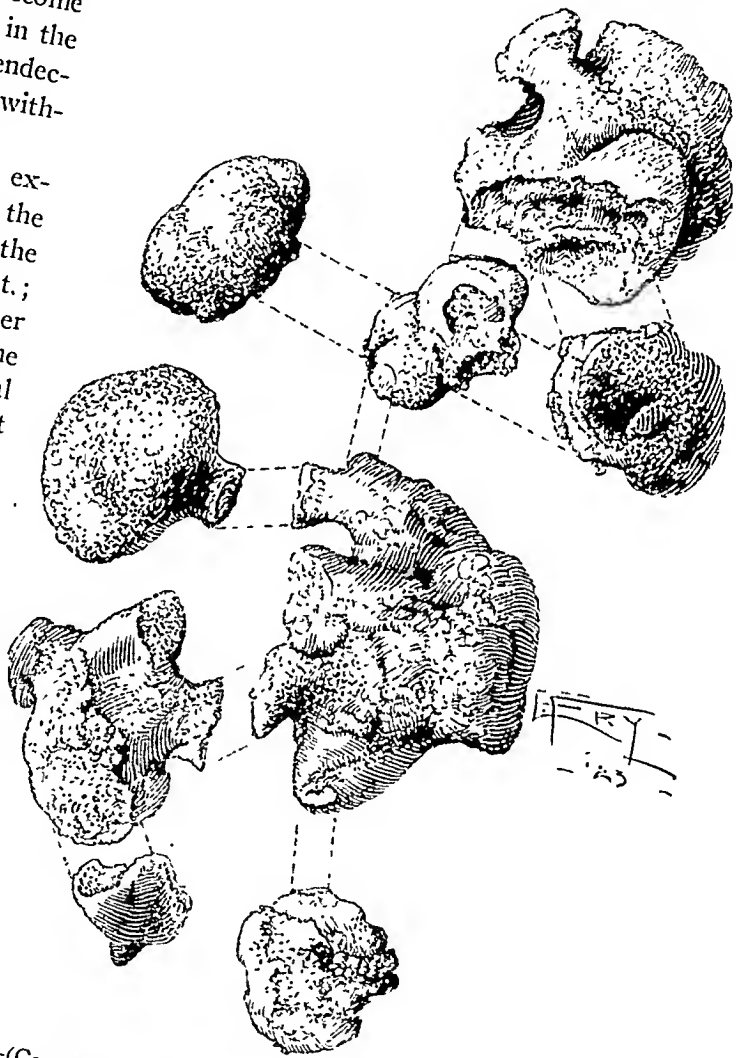


FIG. 8.—(Case A138795.) Squamous-cell tumor of the pelvis. Large irregular coraliform type of stone from the pelvis of a kidney.

extension along the renal vessels and out into the perirenal tissues. Histologically the invading tissue was found to be a squamous-cell epithelioma with evidence of extremely active malignant growth (Fig. 5). Near the pelvis there was extensive desquamation and hyalinization, but no papillary structures were found. In the parenchymal portion of the kidney the malignant cells were large, markedly irregular in size, stained deeply, and contained a great many mitotic figures. Only small areas of normal renal, parenchymal tissues remained. Malignant cells were found encircling moderately atrophic glomeruli and following the course of collecting tubules. In some areas the parenchymal tissues were found unchanged by the encroaching malignant cells, indicating a comparatively rapid and recent invasion. The squamous-cell changes were confined to the tissues adjacent to the pelvis.

CASE III.—(A232,253.) J. T. R., a man aged fifty-four years, came to the Clinic

May 6, 1909, complaining of frequency and occasional attacks of moderate hæmaturia during the preceding ten years. During the last six weeks he had attacks of severe pain localized to the area of the right kidney, and had lost twenty-five pounds in weight. The pain was not so intense if he drew up his right leg.

Examination revealed a mass in the region of the right kidney. At operation a large infected kidney was removed through a Mayo lateral kidney incision. The kidney was adherent to the surrounding tissues and a sub-capsular nephrectomy was necessary. Forceps were left on the pedicle, and five strips of iodoform gauze were packed in the wound. The forceps were removed on the fifth day and the patient left the hospital on the sixteenth

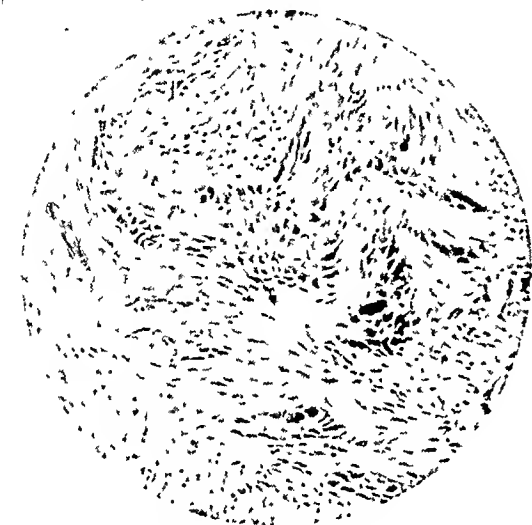


FIG. 9.—(Case A3809.) Extensive fibrosis causing distortion and constriction of an epithelioma of the renal pelvis.

day after an uneventful convalescence. Two months later the patient died. Necropsy revealed metastatic growths in the regional lymph-glands and in the liver.

Pathology.—The kidney was lobulated and soft. On cut section it was found to be almost completely atrophied and contained a huge staghorn calculus. Lining the pelvis and the calices, which were dilated and outlined by only a thin shell of cortical tissue, was a flat, irregular, somewhat villous growth. Histologic examination revealed a squamous-cell epithelioma with extensive hyalinization and epithelial pearl formation (Fig. 6). In most places the growth was confined to the lining membrane of the pelvis and calices, extending only slightly in several areas into the remaining parenchymal tissues.

CASE IV.—(A138,795.) C. E. T., a man aged fifty-four years, came to the Clinic August 7, 1915, complaining of attacks of right renal colic and intermittent hæmaturia of twelve years' duration. Recently the pain over his right kidney had become more severe, and he had lost weight.

Examination revealed a smooth mass in the right abdomen. The urine contained a large amount of pus and blood; the phenolsulphonephthalein return was 44 per cent. in two hours and fifteen minutes. A röntgenogram revealed a large branched stone in the right renal area. Cystoscopic examination revealed a moderately inflamed bladder; the right ureteral orifice did not contract, and no secretion was seen during ten minutes' observation; the right ureter was catheterized and a small amount of cloudy urine obtained; the left ureter had an impassable obstruction at the orifice.

SQUAMOUS-CELL TUMORS OF THE RENAL PELVIS

At operation a large solid, fibrosed kidney was removed. The patient recovered readily, leaving the hospital on the seventeenth day, but gradually became weaker and died two months after the operation.

Pathology.—On section, numerous fragments of a hard, black, irregular stone were found imbedded in firm masses of tough fibrous tissue (Figs. 7 and 8). There was no evidence of any normal kidney tissue remaining; the pelvis and calices were completely obliterated by an overgrowth of fibrous and malignant tissue. Histologic examination revealed a squamous-cell epithelioma. The normal mucosa surrounding the stones was replaced in many areas by a thickened, extensively hyalinized membrane; in other areas, due to infection and necrosis, no definite histologic structure could be made out.

CASE V.—(A3809.) W. W., a man aged sixty-four years, came to the Clinic November 16, 1907, because of a mass in the abdomen, first noticed two months before. He had had several attacks of abdominal pain nineteen years before. For the last sixteen years he had had intermittent attacks of hæmaturia, during the last six months this hæmaturia had been almost constant, and was associated with severe pain in the left loin. He had lost 30 pounds in six months.

Examination revealed a pale, emaciated old man with a palpable tumor in the left side of his abdomen. The tumor was about 12 cm. in diameter and moved on respiration. Cystoscopic examination revealed frequent spurts of clear urine coming from the right ureteral orifice; the left orifice was slowly exuding thick, hemorrhagic, cloudy fluid. A left nephrectomy was performed. The patient had an uneventful recovery from the operation, but never completely recovered his strength, and died several months later.

Pathology.—The kidney was increased in size and contained a number of large, irregular stones. The tissues adjacent to the renal pelvis and to the calices were soft, friable and white in color, and extended in irregular bands throughout the renal cortex. Histologic examination revealed a squamous-cell epithelioma originating in the areas adjacent to the pelvis; bands and masses of tumor cells also extended into the deeper tissues. There was a moderate hyalinization and epithelial pearl formation, together with an extensive fibrosis of the whole kidney. There were numerous large irregular cells, many of them containing mitotic figures (Fig. 9).

SUMMARY

Squamous-cell tumors of the renal pelvis probably result, in most cases, from chronic irritation, are highly malignant, rapidly involve the renal parenchyma and neighboring tissues, and readily metastasize. This type of growth is at times found in association with renal calculi, which are rough, irregular, and of tremendous size. Owing to the lack of symptoms suggesting a malignant condition, these tumors are rarely seen when the growth is small or localized to the renal pelvis. The operative mortality is high, and the majority of patients who survive die shortly after the operation from local recurrences, or metastatic growths.

Five cases of squamous-cell tumors of the renal pelvis have been observed at the Mayo Clinic between 1907 and 1922. Four of these cases were associated with renal stone; the calculi in three kidneys were extremely large and of the staghorn type. One patient died eight days after operation, three others died during the first four months. The fifth patient is alive without symptoms of recurrence six months after operation.

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SURGICAL TRAUMA OF THE RECURRENT LARYNGEAL NERVE WITH RESTORATION OF FUNCTION

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IN THE ANNALS OF SURGERY, February, 1924, Frazier discusses the problem of paralysis of the vocal cords following surgical trauma to the recurrent laryngeal nerve and reports four cases in which improvement followed anastomosis of the distal stump of the divided nerve with the descendens hypoglossi. Several years ago Judd, New and Mann¹ reported experimental study of the regeneration of this nerve and the restoration of its function after surgical trauma. They concluded that:

"1. Section of the recurrent laryngeal nerve produces complete paralysis of the vocal cord of the corresponding side, which in all probability will be permanent.

"2. Ligation of the recurrent laryngeal nerve with linen, chromic catgut or plain catgut produces complete and probably permanent paralysis of the vocal cord of the corresponding side.

"3. Stretching the recurrent laryngeal nerves acutely in a manner similar but of longer duration and intensity than occurs in operation does not impair the function of the vocal cord.

"4. Stretching the recurrent laryngeal nerves for a long period, as over muscles, impairs the function of the vocal cords, but the impairment is probably due to the operative trauma and not to the stretching.

"5. Pinching the recurrent laryngeal nerves with a hæmostat in a manner similar to that which may occur in an operation produces temporary paralysis of the vocal cords. Restoration of function always occurs, the length of time necessary for restoration depending on the anatomic point at which the nerve was crushed. The time found necessary for complete regeneration of the nerve when injured in the areas usually traumatized by operation varies between thirty and sixty days.

"6. Exploration of the recurrent laryngeal nerve produces an effect on the vocal cords depending on the amount of trauma to which the nerves are subjected. Careful dissection will probably not produce any effect; the paralyses noted were probably owing to pinching and other traumatic procedures."

In the case which is here reported an operation was being done for unilateral ligation of the superior thyroid artery at the upper pole of the thyroid. During the dissection the recurrent laryngeal nerve was mistaken for the artery and was doubly tied with fine silk ligatures and partially divided between the ligature before the mistake was discovered. Paralysis was immediate, and

¹ ANNALS OF SURGERY, 1918, vol. lxvii, pp. 257-262.

TRAUMA OF RECURRENT LARYNGEAL NERVE

was repeatedly verified by expert laryngoscopic examination. The patient was carefully observed in the follow-up clinic, later underwent a partial thyroidectomy and at the present time has entirely regained the function of the injured nerve.

Because of the accurate knowledge of the type and the extent of the trauma inflicted with subsequent complete recovery from the paralysis which immediately followed, this report is made.

The patient, a Chinese male student, aged twenty-one, was referred by Doctor LaForce, of Tsing Hua College, with the diagnosis of hyperthyroidism. On admission he showed the characteristic signs and symptoms of Graves' disease, with a basal metabolic rate of 66.5 per cent. above normal. His condition was so advanced that it was thought prudent to do a preliminary ligation under local anæsthesia.

August 5, 1922. After local infiltration of .5 per cent. novocain-epinephrin solution, a short transverse incision was made over the upper pole of the palpable gland on the right side. The preglandular muscles were split vertically and retracted, the upper pole of the gland being easily exposed. A pulsating cord was seen at the inner margin of the upper pole, and in spite of some doubt as to its identity, two fine silk ligatures were tied about it 0.5 cm. apart. These ligatures were then used to raise the cord from its bed, and partial section of it was made with a scalpel. Approximately one-half of it had been divided when cut ends of nerve fibres were recognized. The patient was immediately asked to speak, and was found to be characteristically hoarse. The silk ligatures were at once divided and removed. The remaining undivided nerve tissue served to hold the cut ends in good approximation and no attempt was made to suture them. The superior thyroid artery was then identified lateralward, tied and cut close to the upper pole of the gland. The pulsation erroneously observed in the nerve was later seen to be transmitted impulses from the artery.

The clinical picture improved after this ligation, but the patient left the hospital without improvement in his voice. Examination made August 8, 1922, by Dr. Harry Slack, Visiting Professor of Otolaryngology, showed complete paralysis of the vocal cord on the right side. The patient was seen again a month later and no improvement had occurred in his voice. Upon advice he left college, and rested a year at his home in Shansi Province, returning for further treatment in November, 1923. Examination on admission showed marked improvement in his general condition, the quality of the voice was normal, and laryngoscopic examination by Dr. A. W. Dunlap, Professor of Otolaryngology, in the Peking Union Medical College, showed both cords to be entirely normal in function. On December 1, 1923, a partial thyroidectomy was done under ether anæsthesia. The operation was easy, the gland was rather more fibrous than usual and presented grossly the typical picture seen in exophthalmic goitre. After operation, laryngoscopic examination was repeated by Doctor Dunlap on December 7th and the cords were again found to be entirely normal.

The case presents definite evidence of immediate and complete paralysis of one vocal cord after double ligation with fine silk of one recurrent laryngeal nerve with hemi-section between the ligatures, which were removed as soon as the mistake was discovered. Restoration of function was complete within sixteen months.

TRANSACTIONS

OF THE

PHILADELPHIA ACADEMY OF SURGERY

Stated Meeting Held April 7, 1924

The President, DR. EDWARD S. HODGE, in the Chair

ECHINOCOCCUS CYST OF THE OMENTUM

DR. K. KORNBLUM presented an Italian man, aged twenty-eight years, who was first seen by him October 28, 1923, complaining of a tumor in the right upper abdominal quadrant. He had been perfectly well until four months prior to admission, when he noticed some soreness in the right upper abdomen where he then felt for the first time a large mass that he could easily move about. He thinks the mass gradually increased in size from the time that he first noticed it. He had been in this country for the past twelve years. In Italy he was employed as a carpenter and in this country he has always worked in a factory. He had never been in intimate contact with dogs. He was muscular and well nourished, apparently in perfect health.

Examination was entirely negative with exception of the abdomen. Here a large tumor could readily be seen in the upper right quadrant, about the size of a cocoanut. This was not tender to palpation, presented a smooth surface and had a tense, cystic feel. It moved downward on respiration, appeared to be independent of the liver and no enlargement of this organ could be detected. The mass was freely movable in the upper abdomen and could be pushed slightly beyond the midline toward the left. In a downward direction it could be made to reach the level of the umbilicus. The mass appeared to have its centre of rotation about the gall-bladder. It could not be palpated with the hand in the right kidney region, neither could the right kidney be felt. A dull note was elicited on percussion over the tumor. No hydatid thrill was detected. No other masses were felt in the abdomen and the other abdominal viscera appeared normal. Peristalsis was normal and there was no abdominal distention. He was admitted to the service of Dr. George P. Muller, operation was performed on November 3, 1923, under gas-ether anaesthesia. A transverse incision in the upper right quadrant of the abdomen was made. The mass immediately presented itself on opening the peritoneal cavity and was seen to be a large cyst enmeshed in the great omentum and not attached to any of the neighboring viscera. The omentum was bound by adhesions to neighboring structures and could not therefore be removed from the abdomen. Consequently the cyst was walled off from the remainder of the peritoneal cavity by gauze packs and its removal proceeded with. In attempts to free it, the cyst wall was ruptured and immediately numerous daughter cysts escaped, thus revealing the true nature of the cyst. The entire growth was removed and after removal of the packs the abdomen was irrigated with a weak iodine solution. Further exploration of the abdomen revealed no other cysts. The abdomen was closed and the patient made an uneventful recovery. Pathological examination of the cyst showed it to have the usual characteristics found in echinococcus cysts. The patient has returned twice for follow-up examinations and states that he remains perfectly well. Physical examinations on both occasions were negative.

ECHINOCOCCUS CYST OF THE OMENTUM

Echinococcus cyst of the omentum is but one of the varieties of this parasitic infestation of the peritoneum. Much of the literature concerning hydatid disease comes from Australia from which fact an inference may be drawn that the disease is probably encountered there as often as anywhere in the world. And yet the occurrence of peritoneal echinococcus cyst is a condition of comparative rarity in that country, as pointed out by Fairley who, states that, "Echinococcal infestation of the peritoneum is a relatively uncommon disease." In a series of 300 cases of hydatid disease encountered in 13 years only 25 were found to be of peritoneal origin. This author gives a rather lengthy dissertation on the occurrence of echinococcus cysts of the peritoneum showing that the disease occurs in two forms, either as a single cyst, such as the case reported this evening or as multiple cysts. Of the two varieties the occurrence of multiple cysts is about twice as common as the single variety. The single cysts are thought to be the result of an active migration of the embryo from the gastro-intestinal tract, while in the case of multiple cysts the most likely origin is from the rupture of a liver cyst either spontaneously or at time of operation. In Fairley's series of cases 88.2 per cent. gave a history of a previous initial operation for abdominal hydatid disease or of some previous acute abdominal crisis often traumatic in origin. The diagnosis becomes relatively simple in the case of multiple cysts because of this history of previous disease, but more difficulty is encountered with the single variety. In this respect it is interesting to note that in Fairley's eight cases of single cysts none were correctly diagnosed prior to operation. He calls attention to the fact that single cysts occur most frequently in the pelvis and in this situation in the male the most common error in diagnosis is to mistake the cyst for an enlarged prostate while in the female the cases are frequently diagnosed as ovarian cysts or myoma uteri.

As to the symptomatology, there is usually nothing more than the presence of single or multiple masses in the abdomen associated with various pressure symptoms depending upon the situation of the cysts. Certain complications are occasionally met with, the most common being a calcification of the cyst wall which results in an increased hardness of the mass and thus leads to the diagnosis of a solid tumor. Suppuration may occur in the cyst with its resulting toxemia which thus increases the difficulty of diagnosis. And finally a cyst may rupture. This quite commonly follows an injury to the abdomen. In addition to the symptoms of an acute abdominal catastrophe there are those resulting from the anaphylactic response on the part of the body to the fluid of the cyst. This is manifested by severe collapse, dyspnoea, cyanosis, vomiting and diarrhoea, rapid and barely perceptible pulse and later the occurrence of a symptom which is practically pathognomonic for the rupture of an echinococcus cyst is the development of urticaria. Thus the history of an acute abdominal catastrophe in a native from southern Europe associated with collapse and urticaria practically makes the diagnosis of the rupture of an echinococcus cyst.

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PHILADELPHIA ACADEMY OF SURGERY

ANKLE FRACTURES

DR. E. L. ELIASON reported the following cases:

I. *Fracture of the Tibia and Astragalus with Dislocation of the Latter.*—The patient, a young man, had his foot caught between an ascending construction elevator and the side of an open shaft, with a resulting twist that threw him over the side to the ground, 30 feet below. Fluoroscopic examination revealed a fracture of the lower end of the tibia passing obliquely across the shaft and entering the joint, a fracture of the neck of the astragalus and an internal postero-lateral dislocation of the head of the astragalus with a 90 degree rotation of the same. Open reduction was required at which the tibialis anticus tendon was found between the fragments of the tibia. The head of the astragalus was entirely separated from its attachment. Reduction and plating of the tibia. The patient is now fourteen weeks later, walking with a cane.

II. *Bilateral Fracture of the Astragalus, Tibia and Fibula.*—A young woman, while riding in the side car of a motor cycle was subjected to a head on collision. The neck of the left astragalus was broken, dislocated laterally, accompanied by a fracture of the external malleolus. The neck of the right astragalus was broken, the head was dislocated laterally and both malleoli were broken. The patient was walking without a cane six months later, her only complaint being weak arches for which she wears supports.

Stated Meeting Held May 5, 1924

The President DR. EDWARD B. HODGE in the Chair

PLASTIC SURGERY OF THE FACE

DR. ROBERT H. IVY presented a man, seventy-one years of age, who for the preceding five years had been the subject of a slowly advancing ulcerative lesion of the skin of his nose. The skin of the entire nose was involved, presenting red thickened areas, large scales and crusts, which when removed exposed ulcerations. The ulcerative process had destroyed most of the left ala through its entire thickness, the skin of the columella, part of the cartilaginous septum, and the skin of the right ala. (Figs. 1 and 2.) Very little pain was experienced. Wassermann reaction was negative. General physical examination revealed no other serious defects.



FIG. 1.—Side view of nose lesion.

A plaster-of-Paris impression of the face was taken and a cast made of the same material. From this measurements were accurately made of the nose, which had been reconstructed in wax on the model, from which a tin-foil pattern was reproduced giving the exact shape and size of a forehead flap to be used in reconstruction of the nose. At the first operation, December 21, 1923, under ether, the flap of skin and subcutaneous tissue the size and shape of the tin-foil pattern was raised from the forehead and sutured back in place for

PLASTIC SURGERY OF THE FACE

delayed transfer to the nose (Blair, V. P., Surg., Gynec. & Obst., 1921, vol. xxxiii, p. 261). On January 15, 1924, under ether, all of the diseased portions of the nose were excised. These included the whole of both alæ, the tip, the columella, the cartilaginous septum and all of the skin of the dorsum up to the



FIG. 2.—Front view of nose lesion.



FIG. 3.—Defect of nose replaced by forehead flap.



FIG. 4.—Side view after severing pedicle and returning it to forehead.

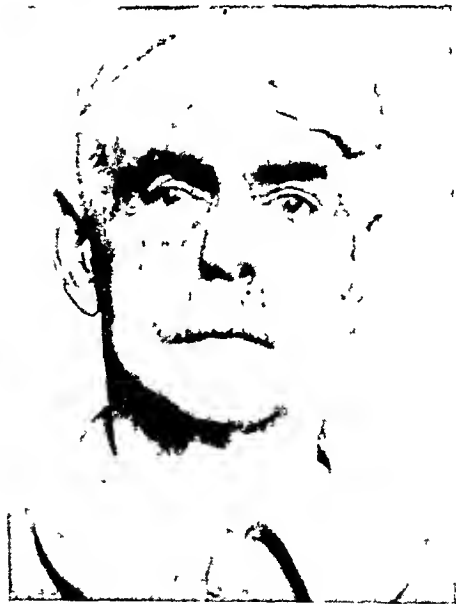


FIG. 5.—Front view after severing pedicle.

frontal bone. After control of hemorrhage, the forehead flap previously outlined was again raised, and sutured down into position so as to restore the missing parts (Fig. 3). The flap was so fashioned that its distal end could be turned in to form the lining of the nostrils and the columella, as well as supplying the external covering of the nose. This particular method of forming the flap made from an accurately measured pattern and furnishing in one piece, lining, columella and external covering, was devised by V. P. Blair, of St. Louis, by whose permission I am presenting it for the first time, as it has not yet been

published by him. Examination of the discarded tissue showed basal-cell epithelioma. On February 14, 1924, four weeks later, under ether, the pedicle was divided and its proximal end replaced in the forehead. The remaining raw surface on the forehead was allowed to granulate for a time and finally covered with a Thiersch graft under local anæsthesia. (Figs. 4, 5 and 6.)



FIG 6—Showing well-formed nostrils with airway.

Owing to the fact that the nasal bones and bony septum were not involved in this case it was unnecessary to insert any new bone or cartilage. Healing occurred promptly, giving the patient a natural-looking nose, with well-formed alæ and nostrils through which he can breath and blow. Time alone will determine whether or not the original lesion is cured, but it is hoped that the patient, who had been condemned to a miserable life of hopeless isolation, will be given at least a few more years of happiness.

Details in the steps of procedure in this Indian method of rhinoplasty as designed by Blair are :

(1) Making of a plaster-of-Paris cast of the patient's face.

(2) Building up of the defective structures to the desired form on the cast in wax or clay.

(3) Measuring the dimensions of the nose on the cast and plotting these out on paper (see diagram Fig. 7), making allowances for columella and lining of nostrils.

(4) Reproducing the paper plan in heavy tin-foil (Fig. 7).

(5) Applying tin-foil pattern to forehead, the pedicled flap is outlined, raised, and sutured back into original bed for delayed transfer (Fig. 8).

(6) Two weeks later, all external surface of nose is removed together with diseased or deformed deeper

tissues, the forehead flap is raised and its distal end is turned in and sutured with catgut to form columella and lining of nostrils (Fig. 9). The flap is then rotated on its pedicle and sutured to edges of nasal defect, particular care being taken to fix posterior end of columella securely to top of upper lip.

(7) Three or four weeks later, pedicle is divided along line from top of one ala to nasion. Raw edge is sutured, and pedicle returned to forehead.

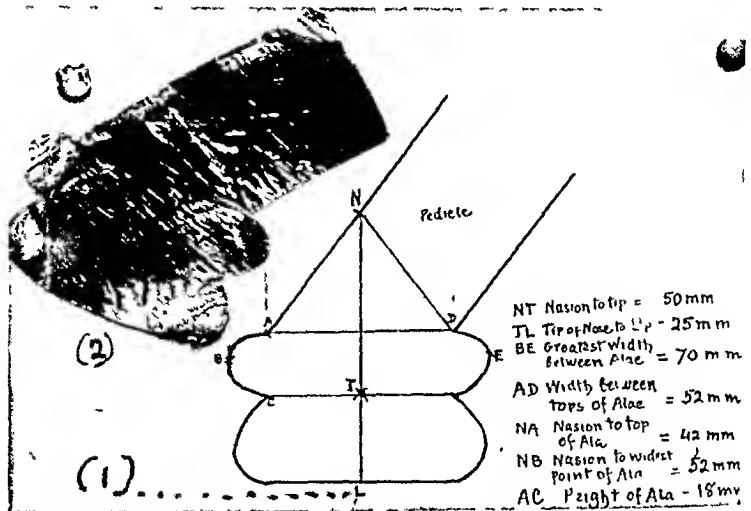


FIG 7.—(1) Dimensions of flap for new nose plotted out on paper (2) Paper plan reproduced in tin-foil.

PLASTIC SURGERY OF THE FACE

(8) Remaining defect in forehead can be immediately covered with full-thickness skin graft from abdomen, or later covered with Thiersch graft.

In most cases, even of total destruction of the nose, this soft tissue flap alone will restore the natural prominence of the nose without a bone or cartilage transplant. If more stability is desired, a piece of costal cartilage can be inserted later. Dr. Douglas Webster, of the Evans Institute, University of Pennsylvania, made the plaster casts.



FIG. 8.—Plaster cast showing nose built out in wax and position of forehead flap.

DR. ROBERT H. IVY presented, also, a child eleven years of age, who had a large defect in the right side of the nose and cheek, exposing to view the interior of the nose and maxillary sinus. The defect communicated with the mouth through a small opening in the alveolar process on the right side. There was a loss of several teeth and surrounding bone in this region. The right ala was absent. From contraction of scar tissue the right corner of the mouth was drawn up at the expense of the upper lip. The remaining part of the nose was drawn toward the right. (Fig. 10.) This deformity is said to have resulted from noma following typhoid fever at the age of three years. On the right cheek are two parallel scars about an inch apart running downward and backward toward the neck, apparently due to a previous attempt at closure of the defect. The procedure for relief in this



FIG. 9.—Under surface of flap, showing method of folding distal end to form columella and lining.

case was as follows: A plaster-of-Paris cast of the face was made and the defect built out to as nearly correct contour as possible in wax on the cast. From this a tin-foil pattern was made to give correct size and shape for a skin flap to cover the defect.

At the first operation, using the tin-foil pattern, a horizontal skin flap was outlined and raised from the forehead with its pedicle based at the right superficial temporal artery. This flap was sutured back into its original bed for delayed transfer to its new position. At the same operation a flap of skin was raised from

the right infraorbital region, to be turned over like a hinge at the edge of the defect, to line the cavity with epithelium. This flap was also sutured back for delayed transfer.

Two weeks later, the nasal edges of the defect were freshened and the infraorbital flap raised, inverted, and sutured to the freshened nasal margin. The raw surface thus created on the cheek and the under surface of the hinge flap were covered by the horizontal flap from the forehead. (Fig. 11.)

Two weeks later, good union having occurred, the temporal pedicle was severed and returned to the forehead. The raw edge of the flap was sutured to the cheek. The opening into the nose was thus closed, but there remained

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the drawn up right corner of the mouth. (Fig. 12.) This was corrected by dividing the scar tissue in the upper lip, bringing the corner of the mouth down, and filling the space thus created by interposing a thick tongue-shaped flap of skin and subcutaneous tissue from the lower lip. (Fig. 13.) Massage



FIG. 10.—Showing defect in side of nose.



FIG. 11.—Temporal-pedicled forehead flap brought down to close defect.



FIG. 12.—Temporal pedicle severed and returned to forehead. Right corner of mouth still drawn up.



FIG. 13.—Present condition, after adjustment of corner of mouth with ascending flap from lower lip.

and time are expected to do much to obliterate the scars of these various operations. Further correction of the nasal deformity may be attempted later.

COMPOUND FRACTURE-DISLOCATION

DR. DRURY HINTON (by invitation), presented a man, forty-five years old, who was admitted December 24, 1922 with a *compound fracture-dislocation at the wrist*. The radius protruded from the flexor surface, connected with the semilunar. Vessels and nerves retracted and posterior. Four hours after admission, operation was performed, the semilunar being removed and the

MASSAGE OF THE HEART IN CARDIAC ARREST

wound closed without drainage after replacing the tendons and vessels. Put in splint; slight fixation, active motion in 3 days, drainage for 2 days. Left the hospital on the ninth day and was referred to surgical dispensary and at the end of three weeks was off splint and at the end of four weeks, was back at work. His work is that of a painter and he still has some slight difficulty. An interesting feature of this case was that the wound was filled with paint and turpentine.

CASE II.—*Compound Fracture-dislocation of the Elbow.*—Patient fell 20 feet and had a Colles' fracture of the right wrist and a compound fracture-dislocation of the left elbow. The humerus was pushed out one inch from the inner aspect of the arm. Fracture of the epicondyle and also fracture of the other condyle. Brought in $3\frac{1}{2}$ hours after accident. Operation and placed in Jones position, small rubber tissue drain, removed at the end of 48 hours, active motion for 3 days, then motion every other day for three weeks, then all dressing removed and he returned to work in three months. Since then has had no trouble. Full flexion, supination and pronation.

TRAUMATIC PNEUMOTHORAX

DR. T. J. RYAN (by invitation) reported the case of a boy seven years of age who was admitted to the Misericordia Hospital on December 7, 1923, on Doctor Muller's service with the history that an auto truck had passed over the lower part of his right chest. Upon admission shortly afterwards he was found suffering from severe shock with a sub-normal temperature, a pulse rate of 120 and a respiratory rate of 48. He was coughing and vomiting blood. He was not totally unconscious. Examination revealed distention and rigidity of the right thorax, drum-like resonance, and evidence of injury to the ribs. There was marked distention and rigidity of the abdomen with considerable tenderness over the hepatic area.

Stimulants and an intravenous infusion of saline solution were administered within an hour after admission. Two days later, although the condition of the patient was poor and his heart sounds very feeble, an X-ray picture was taken of his right chest which disclosed fractures of the fourth, fifth, seventh, eighth and ninth ribs with a pneumothorax of the entire chest and a complete atelectasis. The right chest was aspirated and air escaped under considerable pressure. The patient was immediately benefited and an X-ray picture taken on December 17, 1923 revealed expansion of the right lung to about 60 per cent. of its normal size. The patient was discharged twenty days after admission having no symptoms except very slight pain over the chest wall. His respiratory rate was 24, his pulse 100 and his temperature 98.

This condition is not a frequent complication of civil injuries, having been the first one that occurred in this service at the above hospital in five years and but few have been described in the literature since 1917. It seems to be the consensus of opinion that these cases will recover without aspiration, but it would seem that the treatment which was instituted was instrumental in hastening recovery.

RESUSCITATION OF AN ARRESTED HEART BY DIRECT CARDIAC MASSAGE

DRS. WALTER ESTELL LEE, and T. MCKEAN DOWNS read a communication with the above title for which see page 555.

PHILADELPHIA ACADEMY OF SURGERY

SURGICAL TREATMENT OF BRONCHIECTATIC CAVITIES

DRS. THOMAS A. SHALLOW and LOUIS H. CLERF read a paper with the above title.

LATE RESULTS OF SPLENECTOMY FOR TRAUMATIC RUPTURE
OF THE SPLEEN

DRS. DAMON B. PFEIFFER and CALVIN M. SMYTH, JR., read a paper with the above title, for which see page 562.

BILIARY TRACT SURGERY

DRS. JAMES H. BALDWIN and WILLIAM R. GILMOUR read a paper on Biliary Tract Surgery, based upon a study of 130 consecutive surgical cases.

TRANSACTIONS OF THE NEW YORK SURGICAL SOCIETY

Stated Meeting Held April 9, 1924

The President, DR. EUGENE H. POOL, in the Chair

BILATERAL STRANGULATED INGUINAL HERNIA IN THREE MONTHS' OLD BABY

DR. HENRY W. CAVE presented a child, a premature seven months' baby, at the present time aged three months, who was admitted to the Second Surgical Division, Roosevelt Hospital, March 7, 1924.

Forty-four hours before a left indirect inguinal hernia came down into sac and became irreducible. The bowels moved four hours prior to admission. The patient was vomiting about every hour. Fecal odor to vomitus.

The baby was poorly developed, and had a hard irreducible mass in left scrotal sac. Hoth baths; ice-bags and upright elevation of buttocks failed to reduce hernia.

Forty-five hours after hernia became incarcerated the patient was operated upon. Drop ether anæsthesia. Inguinal canal exposed. Release of constricting ring. Several loops of small intestine congested and bluish in color reduced. Closure of neck with fine catgut. Sac not removed. Wound closed. Satisfactory recovery.

Eight days post-operative: A bulging mass appeared in the region of the right external ring. Was reduced with some difficulty. Ether had to be given. Four days later this bulging mass again came down into sac and was irreducible. Under ether anæsthesia, this right-sided irreducible indirect inguinal hernia was operated upon. Numerous loops of small intestine of bluish color reduced. Suture of neck. Closure of wound. Slight amount of infection, lower angle. Satisfactory recovery.

STRANGULATED INGUINAL HERNIÆ WITH BEGINNING GANGRENE OF TESTICLE IN THREE AND ONE-HALF MONTHS' OLD BABY

DOCTOR CAVE presented a child who, when a baby three and one-half months old, was admitted to the Second Surgical Division of Bellevue Hospital, March 2, 1923, at 10 A.M., for relief of strangulated right indirect inguinal hernia of fifty-five hours' duration.

Operation was performed within an hour of patient's admission. Drop ether anæsthesia. Incision over inguinal canal. A loop of small intestine filled with semi-solid fecal matter was found caught in the external ring and pressing firmly against the cord. The loop of gut was a very dark brown, not quite black. The entire cord, the testicle and epididymis were black. After a slit was made in the ring and the gut drawn out, the circulation was restored in a few minutes. The scybalous mass pushed upward in lumen of gut. Hernia reduced. Cord and testicle still black. Even in spite of the threatened gangrene of the testicle and cord, it was thought best not to remove them. Closure of hernia opening, repair of canal in usual way. Child made an uneventful recovery. Discharged cured from hospital nine days after operation.

BRAIN TUMOR

DR. CHARLES A. ELSBERG presented a woman, thirty-four years of age, from whom he had removed an endothelioma from the left motor area, under local anæsthesia, in January, of last year. One year before she began to have attacks of twitching in the right hand and forearm which continued off and on and which was soon followed by attacks of twitching of the right side of the face and right upper and lower extremities. She was never unconscious during the attacks and they occurred every few days. She was treated in the Out-patient Department, where it was found that she had a four-plus Wassermann, and received thorough antispecific treatment. She never had any headache and never vomited. She was admitted into the hospital in a condition of status hemi-epilepticus. Every ten to fifteen minutes she would have a convulsive attack which began in the right upper extremity and then involved successively the right side of the face and the right lower extremity. She was conscious during all of the attacks. She was under observation for two days during which time there was progressive weakness of the limbs on the right side. Upon physical examination, her fundi were found to be normal, tendon reflexes on the right side greater than on the left with a Babinski on the right and with marked weakness of the right upper and lower extremities. The Wassermann in the blood and cerebrospinal fluid was negative. At the operation, a well encapsulated endothelioma, 5×4 centimetres in size, was removed from the left arm area. As there was a great deal of bleeding from the cavity in which the tumor lay, a small piece of muscle was removed from the thigh and inserted in the cavity and the bleeding thus controlled. The patient recovered very satisfactorily from the operation. She rapidly regained power in the right side of the body and was free from the Jacksonian attacks. She returned to the hospital three months later and was then practically well. Two months after this she began to have recurrences of her attacks and by November—ten months after the operation—she was having attacks every few weeks with again a progressive loss of power in the right upper and lower extremities. November 13, 1923, the bone flap made at the previous operation was again turned down, and the dura opened; the piece of muscle that had been implanted at the operation ten months before was found to be lying loose in the cavity and to have undergone fibrotic change. The piece of muscle which was 3×2 centimetres was easily removed and the wound then closed. She recovered satisfactorily from the operation, rapidly recovered power in the affected limbs and has been free from the convulsive attacks. When the piece of muscle was incised it was found that there was a collection of pus, sterile on culture, in the centre of it.

In this patient, the implanted muscle acted as a foreign body and had to be secondarily removed. It had caused a recurrence of tumor symptoms. The Wassermann was found to be positive again, and she was put upon renewed antispecific treatment. It seems very probable that the lues had something to do with changes due to the fact that the implanted muscle was not well borne by the tissues, as muscle is usually borne well when it is implanted and never causes any trouble as in this patient.

DOCTOR ELSBERG presented also a woman from whom he had removed a large endothelioma from the left fronto-parietal region. Sixteen months before the operation she complained of some double vision and some dimness of vision. This continued off and on for six months and then she began to have headaches, increasing in severity, and buzzing in the ears. For seven weeks she had had some disturbance in speech, often misnaming objects and people. Upon examination, the reflexes on the right side were slightly exag-

gerated over those on the left. There was a marked papilloedema on both sides and a facial weakness on the right of the central type. The diagnosis of a tumor in the left frontal region was made, and in October, 1923, a large osteoplastic flap was turned down on the left side; the dura was very tense and the attempt to puncture the ventricle was unsuccessful. The patient stood the operation very poorly and further procedures were delayed for four days. The bone flap was then turned down again and the dura widely opened, exposing a large endothelioma, which was excised. There was considerable bleeding from the bed in which the tumor lay, and a large piece of muscle was removed from the thigh and inserted in the bed of the tumor, thus controlling the bleeding. The patient was considerably shocked by the operation, requiring active stimulation and blood transfusion, but she recovered very satisfactorily thereafter.

DOCTOR ELSBERG presented a third patient from whom a tumor had been removed from the same region. This woman first complained of diplopia four months before followed by headache and vomiting. The symptoms persisted and the headaches became gradually more severe, and she complained of a great deal of dizziness and of attacks of coldness in the left side of the face with buzzing in her right ear. There were no convulsions or other symptoms. Upon physical examination, there was a slight increase of the reflexes on the right side, a bilateral papilloedema with hemorrhages and a slight right facial weakness of the central type. There were no speech disturbances. The operation was done in May, 1923, and a large endothelioma removed from the left fronto-parietal region. The patient recovered very satisfactorily from the operation and has remained well.

Both these patients presented very similar symptoms and it was interesting that both of them complained first of double vision, so that the question of encephalitis was considered. Both of them complained of auditory disturbances in the contralateral ear, which is unusual in tumors of this location, and in both of them the paucity of clear physical signs is of interest.

DOCTOR ELSBERG presented a fourth patient from whom he had removed a very large tumor from the right frontal region, under local anæsthesia. The man was seen in an advanced state of tumor symptoms referable to the right hemisphere, with marked papilloedema, diminution of vision and mental disturbances. The tumor was so large that it had to be removed in several pieces. The patient stood the operation very well and recovered satisfactorily as far as all of his symptoms were concerned excepting the visual disturbances. After the operation the papilloedema, which had been of high grade with a large amount of exudate, rapidly subsided, but it was followed by so much postneuritic atrophy that the little vision that the patient had before the operation was almost entirely lost.

This case demonstrates how unfortunate it is to delay operative interference too long, for there is nothing more pathetic than to have a patient lose his vision after a very satisfactory tumor removal.

In answer to a question, Doctor Elsberg said that in his intracranial work for some years he had been making very large bone flaps which extended from above the frontal sinus in front to the level of the mastoid behind and up to the median line. This avoids secondary rongeurage away of bone if the tumor is found near the median line and allows of much freer manipulations. In some instances tumors are well exposed by these large flaps which otherwise might be missed altogether. When the bone flap is returned into place without removal of additional bone, the cranial cavity is closed entirely. If

the tumor is expected in the occipital region, then the bone flap is made further backwards up to the level of the transverse sinus.

COMPOUND COMMINUTED FRACTURE OF SKULL WITH LACERATION
OF BRAIN IN A CHILD FOLLOWING COASTING

DR. HUGH AUCHINCLOSS presented a boy, eleven years old, who on January 15, 1922, two years, three months ago, was brought to the Emergency Ward of the Presbyterian Hospital (No. 52622) by two men who said that while coasting in Central Park he ran into a park bench and cut his head open. Though seemingly unconscious, he responded in monosyllables a few times to questions. He was cyanosed, was somewhat dyspnoeic, had cold, dry

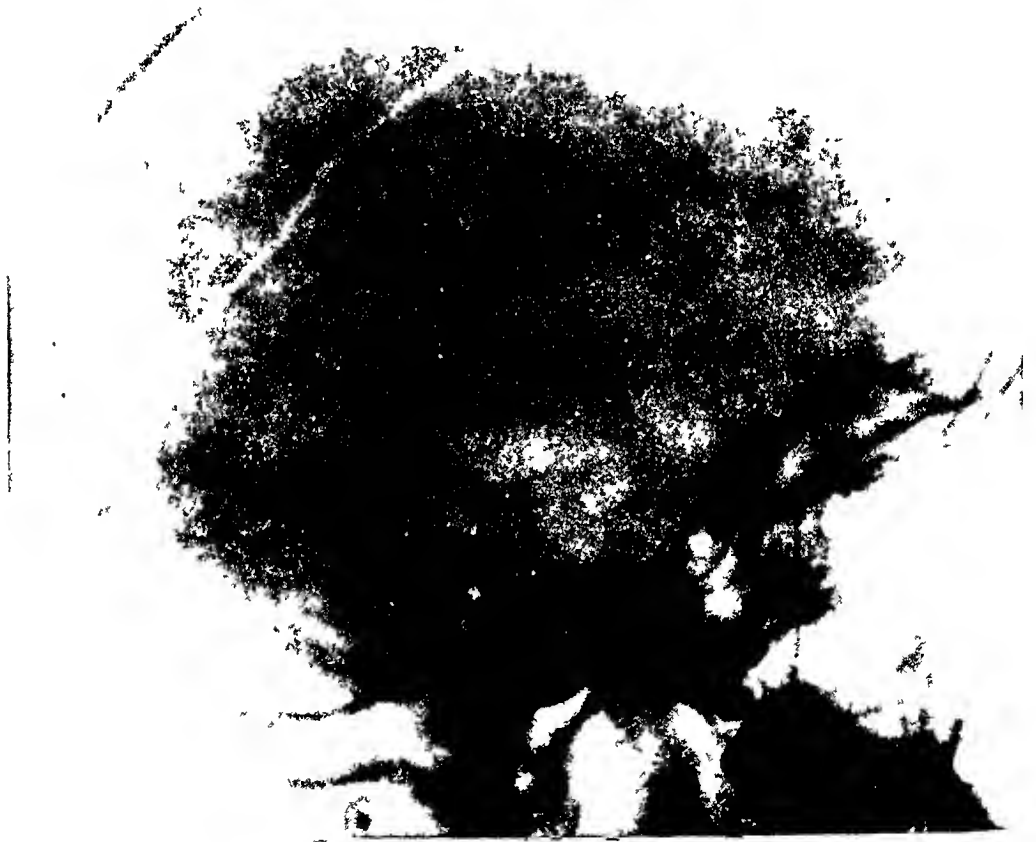


FIG. 1.—Skiagraph showing defect in skull after recovery.

hands and feet and looked shocked. In striking contrast to a fractured skull picture with compression signs, his pulse varied between 120–150, was of good quality, and his blood pressure 125/70.

An irregularly curved scalp wound just above the hair line in the frontal region lay open, exposing blood clot, some dirt, and hair matted together with a friable substance that proved to be bits of brain. No other evidence of injury was found. Dr. H. A. Murray, who was then house surgeon, hurried him at once to the operating room, where he was first seen by the reporter. Great care was taken in the wound preparation. Shaving, cutting

COMMUNUTED FRACTURE OF SKULL IN CHILD

away fragmented flap edges, removing dirt, and gentle irrigation with slightly warmed saline, then Dakin's solution took about half an hour, during which time the pulse ranged between 100 and 150 and the blood pressure 100/40 to 125/75. A little ether had to be given to keep him quiet. The scalp was avulsed from before backward with a pedicle behind. Six fragments of the vault lay depressed beneath the edges of the surrounding normal skull. In most of these fragments the amount of inner table fractured was greater than the outer. They were made up of the frontal and left parietal bones. (Fig. 2.) Close to the longitudinal sinus was a laceration of the dura mater about 2 x 3 cm. in diameter whence came brain tissue. Small fragments of it oozed out. It was thought to be just in front of the upper part of the pre-central convolution. No bleeding vessel of any size was found. The bone fragments were removed. Great effort was made to thoroughly remove all foreign matter, clean and rearrange the tissues, closing the dura and then the flap with as little trauma as possible. Two little rubber drains at either end of the wound were inserted. The last part of the operation was completed by Dr. W. G. Penfield. Subsequent X-rays showed a linear fracture radiating toward base on left side.

The blood pressure remained about the same during the rest of the afternoon and at midnight, though his pulse was 130, he spoke a few words and said he "felt fine."

Except for some relative weakness in the grip of his right hand and an intercurrent attack of tonsillitis his post-operative course was free of noteworthy happening. He went home 23 days after his injury with a pulsating defect in his skull, measuring 6.5 cm. in greatest diameter. (Fig. 1.) Four days later Doctor Penfield noted: "The wound is entirely healed. The surface where the brain was exposed pulsates and is slightly depressed. He has no pain on getting up in the morning or on stooping over, Babinski's are both normal. Abdominal reflexes normal. Strength in right hand normal. No cortical sensory loss can be made out. He has a slight internal strabismus of the left eye which may have been present before. On looking to the left there is a moderate nystagmus with quick phase to the left. On looking to the right there is a fine nystagmus with quick phase to the right. The question of filling in the cranial gap must be considered and determined by such disturbances as headache and focal symptoms."

Four months later. Quite well. Five months later. Broke his humerus. Eight months later. Went with Tribune Fresh-air Party to the country. Nine months later. Quite well. Defect in skull is flat. Twenty-one months later. Pain at site of depression for one week. Very marked pulsation present and it can be seen at a distance. Doctor Penfield advises closure of defect. Thirty-two months later. Occasionally a little dizzy. No headaches. Thirty-five months later. Apparently some difficulty with memory. Passed up a



FIG. 2.—Fragments removed.

grade in school only on trial. On stooping, gets dizzy, also if struck on head. Vomited supper one month ago. Family are not particularly anxious to have any operation at present.

Reasons for presentation of case:

1. The magnitude of the injury received while coasting down what most people would consider a rather harmless looking short, not particularly steep, Central Park hill.

2. Severe brain laceration and loss of substance with relatively insignificant signs and symptoms as compared to apparently much less severe fractures associated with bleeding within the closed cranium. A somewhat dramatic evidence of the value of "decompression" coincident with injury.

3. A three-year follow-up result at eleven to fourteen years of age, showing scarcely any complicating feature as yet. It is hoped that later follow-up results may be obtained and reported.

DR. CHARLES A. ELSEERG said that he thought unless the defect were very large and the patient had a disturbed symptomatology, it was better to allow the flap defect to remain. He considered that in this boy it might remain with perfect safety and with the outlook that in a few years it would decrease in size. Unless there was some special reason for acting otherwise, he would leave that flap alone.

DR. SEWARD ERDMAN was interested to know the indication for the removal of so large an amount of bone. He inquired if there was any reason for believing, if it was not contaminated, it was not safe to leave it in. He believed that in such cases as this an effort should be made to leave in as much of the comminuted bone as possible as it fills in the defect and acts as a bone graft.

DOCTOR AUCHINCLOSS, in closing the discussion, said that at the operation it was a debated point what to do with the pieces of bone. They were taken out and preserved in saline until a decision was reached regarding using them. But there was hair and ground-up dirt mixed with them and Doctor Penfield rejected the use of that bone from the standpoint of the undesirability of having a possible infected foreign body in the wound, especially in a case where the dura had been opened and there was so extensive brain laceration.

SUPPURATIVE ARTHRITIS OF KNEE-JOINT TREATED BY INCISION AND MOTION

DR. FREDERICK T. VAN BEUREN, JR., presented a woman, forty-four years of age, who was delivered at the Sloane Hospital for Women February 1, 1923. Five days postpartum she had a rise of temperature to 104 degrees F., and complained of tenderness in the right lower quadrant of the abdomen. Eight days postpartum she complained of tenderness in both iliac fossæ and the uterus was found to be enlarged and irregular. A diagnosis of septic uterus and probable pelvic thrombo-phlebitis was made. Nineteen days postpartum swelling and tenderness of the right knee-joint was discovered and pus was aspirated which showed streptococcus hemolyticus on culture. He saw the patient for the first time on the following day, and deferred operation for twenty-four hours in order to force the fluid intake and digitalize her because she was in very bad general condition with a temperature varying from 103 to 104, and a white blood count of 18,000 with 83 per cent. polymorphonuclears. February 22, 1923, incisions were made, one on the outer,

TRAUMATIC RUPTURE OF THE LIVER

the other on the inner side of the right patella, draining the knee-joint; immediately upon coming out from the nitrous-oxid anæsthesia, motion of the right knee-joint was instituted, partly active, partly passive, before the dressing was applied. A large quantity of thick pus was forced out of the joint by this movement and redressing with assisted active motion was performed every three hours while the patient was awake during the next two weeks. During the next four weeks, although the blood culture showed no growth on four or five separate occasions, she developed a very large abscess in both gluteal regions one month later and an abscess in the right pectoral region about ten days after the development of the gluteal abscesses. The cultures from the pus in each case grew streptococcus hemolyticus. These complications interfered seriously with the care of the knee-joint. For thirteen weeks the patient ran a more or less high temperature, continuously, and her general condition was very bad indeed. During the greater part of this time active motion at the knee-joint was impossible on account of the patient's inability to perform it, but passive motions were kept up by the interne, Doctor Damon, who had immediate charge of the conduct of the case. Eight weeks after the incisions in the knee-joint had been made, the inner wound had closed off from the joint and was healed at the end of fourteen weeks after operation. The outer wound ceased to discharge at about the same time, but was not healed until about sixteen weeks after the operation. The healing of the wounds in the gluteal and pectoral regions was also very slow, the pectoral wound healing about five months after it was made. There still remains, thirteen months after the operation in the gluteal region, a small sinus over the sacrum.

She got out of bed for the first time eight months after the operation on her knee and began to walk about one month after that, having considerable difficulty on account of contraction of the posterior leg muscles. She is now, thirteen months after the operation, able to walk up and down stairs with moderate ease. She has full and painless active extension of the right knee-joint to an almost complete degree. This case is shown to emphasize the fact that it is possible to secure a good result in suppurative arthritis of the knee-joint by incision and motion of the joint, even in a most unfavorable case, provided sufficient pains are taken by the interne in charge of the case. It is further emphasized that, in this case, passive motion or a combination of assisted active motion with passive motion, took the place of real active motion for a number of weeks and secured a satisfactory result.

DR. ROYAL WHITMAN considered that complete extension at the knee-joint was, from the functional standpoint, more important than freedom in flexion. He thought that in such a successful case an attempt should be made to restore extension and thus to assure stability in weight bearing.

DR. ALLEN O. WHIPPLE considered that this case presented the best proof of the wisdom of operating to restore function in suppurative arthritis occurring in such desperately sick people. These patients with suppurative joints are so often desperately ill in so many other ways that the accomplishment of such a result, as seen in this patient, was a very remarkable one. Most of these cases go on to a bony ankylosis, if they get well at all.

TRAUMATIC RUPTURE OF THE LIVER

DR. BENJAMIN T. TILTON presented a man, twenty-two years of age, who was admitted November 22, to St. Mark's Hospital with a history of having fallen one-half hour before, four stories, while at work on the construction

of a new building. On admission his condition was that of marked shock; blood pressure 100 over 52, temperature normal, pulse 100, respiration 22, red cell count 3,600,000, hæmoglobin 70 per cent. He complained of severe pain in the abdomen and left shoulder, and had vomited before admission.

On physical examination, the patient was pale. The abdomen showed no external evidences of injury, was slightly distended, and there was moderate spasm of the muscles, particularly on the left side. There was marked tenderness in the left upper quadrant. There was shifting dullness in the flanks. Percussion, palpation and auscultation of the chest gave no evidence of thoracic injury. Catheterization of the bladder showed no blood in the urine. The patient had abrasions of the left forehead, fracture of the nasal bones, fracture of the lower end of the left radius, fracture of the left scaphoid and a comminuted fracture through the greater trochanter of the right femur.

Laparotomy was performed four hours after the accident. The abdomen was opened through the left rectus and a very large amount of fluid and clotted blood was found. The spleen was uninjured, but on the under surface of the left lobe of the liver there was a deep tear about four inches in length which extended on to the posterior surface of the organ. The laceration was bleeding freely. As the patient's condition was very critical and the torn surface was very inaccessible for suture the wound in the liver was merely packed with a large amount of plain gauze which was brought out through the upper end of the laparotomy incision. A hypodermoclysis was given on the table. Post-operative condition very bad. With the aid of repeated hypodermoclysis, fluids by rectum and stimulation the patient gradually improved and went on to a slow but complete recovery. One week later the gauze packing was removed under gas and oxygen anæsthesia, liberating a large amount of bloody, broken down liver tissue. There was a discharge of thick purulent material for several days following the removal of the packing. The temperature which reached $104-6^{\circ}$ twelve hours after operation fluctuated in the neighborhood of 102 to 103 until the packing was removed, after which it gradually reached normal.

He left the hospital about eight weeks after admission. He had remained in the ward longer on account of baking and massage of his fractured femur and wrist. An interesting question in this case is the nature of the injury that produced the rupture of the liver. It seems possible in the absence of external evidences of injury to the abdominal wall or thorax that the injury to the liver was not caused by compression of the organ, but rather by a pulling away of the liver from its parietal attachments by the sudden force of the fall. This indirect method of injury is more likely to affect the heavier right lobe; rupture of the left lobe is comparatively rare. The chief point of impact seems to have been over the greater trochanter on the right side which was markedly comminuted. As regards operative procedure, he believed that gauze packing is the method of choice where time is an important element and the hemorrhage is still active. This can of course be combined with suture in suitable cases.

RUPTURE OF THE SPLEEN IN A CHILD FOLLOWING RELATIVELY SLIGHT TRAUMA

DR. FORDYCE B. ST. JOHN presented a child, nine years of age, who was brought to the hospital in a taxicab three months ago by her mother to determine whether or not an injury existed.

The history as presented by the mother was as follows: Two and one-half hours before admission, while in school, one of her little friends gave her a push while she was standing near a school desk and she bumped up against

RUPTURE OF THE SPLEEN IN A CHILD

the corner of the desk, striking her left side and sliding to the floor. Immediately she felt a sharp pain in her left side under the ribs, did not fall down, however, but sat down in a chair for five minutes and then as school was over walked home partly supported by two girl friends, climbed two flights of stairs, and then because she felt badly lay down on a sofa.

About an hour and a half later she felt nauseated and vomited twice, chiefly yellow fluid. This did not alarm her mother as the child in the past several years had not infrequently vomited with so-called indigestion attacks. She did not complain of pain while lying quietly either before or after vomiting but said that walking and moving had hurt her side. A short time later, however, perhaps fifteen minutes, the mother noticed that the child was paler than usual, especially about the lips. Upon arriving at the hospital by taxicab, the child walked into the accident ward with her mother and sat down in one of the receiving chairs to wait for the examining physician.

A half hour later, four hours after injury, when seen by the visiting surgeon, she presented the following picture: A pale child about eight or nine years old lying on the examining table with knees drawn up, apparently not in acute pain, but very quiet. Respirations were quiet and not increased in rate, her pulse rate was 98, fair in quality, the red cell count being 4,500,000 and the hæmoglobin 85 per cent. She seemed like a matter of fact youngster and stated that while lying still she had no pain, but that she felt more comfortable with her legs drawn up. She was not nauseated. The examination of the chest was essentially negative, except for slight diminution in respiratory excursion. The abdominal wall moved with respiration but was also limited in its excursion. A very faint area of ecchymosis was noted over the lower left chest in the splenic area pressure on which caused no pain. It was difficult for the child to relax her general abdominal wall with the thighs extended. With the thighs flexed she presented slight spasm in the upper left quadrant with tenderness and less spasm and tenderness in the lower left quadrant. There was no costo-vertebral tenderness, but very definite dulness in the left flank, not shifting, and tympany in the right. A rectal examination was not made.

It was felt that with the history and the evidence of intraperitoneal injury with hemorrhage and from the location of the blow and the ecchymosis found, a ruptured spleen seemed the most probable pathology with probably some renal injury.

She was operated upon immediately and the following conditions found. Upon opening the peritoneal cavity through a left rectus incision there escaped a large amount of fluid blood and the examining hand placed in the upper left quadrant could readily appreciate a badly lacerated spleen, which, however, upon being brought into view, was not apparently otherwise pathological. The visceral surface presented a longitudinal rent which almost completely divided the spleen into two equal halves. Controlling the pedicle of the spleen with the fingers, clamps were applied including the vessels, and the spleen removed. Large blood clots were noted in the left lumbar gutter and in the left subphrenic region behind the stomach. At the time the spleen was first seen there was very active hemorrhage present. After removal of blood clots in the left lumbar region retroperitoneal hemorrhage was noted in the region of the left kidney, which upon palpation showed no evidence of gross laceration, however. The wound was closed with continuous plain gut for the peritoneum, during which about 350 c.c. of hot saline were introduced into the peritoneal cavity. The anterior sheath was repaired with chromic gut and the skin and subcutaneous tissue with silk. Note: It was estimated that the

amount of blood in the peritoneum including clots was about 400 c.c. A saline infusion was given on the operating table.

The pathological report of Doctor Stout describes the spleen 8 cm. x $5\frac{1}{2}$ x 3 cm. "Its visceral surface presents a longitudinal rent which almost completely divides the specimen into two equal halves. The surfaces along the line of rupture are very jagged, the substance of the spleen bulges forth and there is much blood clot. The rupture goes through to the diaphragmatic surface but there it is not so accentuated. There are, however, three distinct lines of rupture, the main line running somewhat longitudinally, while the other two are perpendicular to this and take their origin from it. Microscopic examination: Section of the spleen taken along the margin of one of the cracks shows adherent to it a mass of coagulum with thick plaques of fibrin and flaklets separating the mass of red blood cells. There has been some degeneration of splenic tissue along the margins of the rupture. There is considerable leucocytic infiltration along the surface of the splenic tissue and into the coagulum. Many of the phagocytic cells of the spleen are loaded with brown granular blood pigment. There is almost no hemorrhage into the splenic tissue itself."

On the day following operation the child was transfused with 400 c.c. of maternal blood and following this the post-operative course was uneventful until the ninth day, when the dressing was noted to be soaked with bright blood and upon its removal a disruption of the wound found which was repaired immediately with general anæsthesia followed by an uneventful convalescence, the patient being discharged from the hospital on the thirty-sixth day following injury with the following blood count: red blood cells, 4,200,000; hæmoglobin, 70 per cent.; white blood cells, 400; polymorphonuclears, 37 per cent.; lymphocytes, 52 per cent.; l. monos. and trans. 10 per cent.; eosinophiles, 1 per cent.

RUPTURE OF LIVER IN A CHILD FOLLOWING COASTING

DR. HUGH AUCHINCLOSS presented a twelve-year-old school girl, who while coasting in Central Park, February 26, 1924, collided with a tree and struck her right side, over probably, from her description and a skin mark, the lower ribs about the anterior axillary line. After being pulled along on her sled for a short distance she was able to stand up but, when she did so, complained of pain in her abdomen much worse on breathing deeply. From Fifth Avenue and Seventy-second Street to First Avenue and Seventy-fifth Street is about ten blocks, or half a mile. She walked this and then up one flight of stairs. Because she looked pale and still complained of abdominal pain her sister brought her to the Presbyterian Hospital (No. 59284) in a taxicab. The physicians who then examined her were called upon to reconcile a somewhat conflicting assortment of facts.

She was thirsty and asked for water frequently. When she breathed, she had much pain referred to the right acromial region, but no evidences of injury were discovered there. She was wholly conscious, talkative and smiled during the remissions of pain and after her chest was strapped. No signs of a rib nor lung lesion could be made out and the heart was not displaced. These negative findings were substantiated by fluoroscopy. Over the tenth rib in the right anterior axillary line was a little reddened skin evidently where she had been struck. The right side of the abdomen, the right flank, and both recti were rigid. In the right costovertebral angle there was no tenderness nor spasm. One of the physicians found on rectal examination that on the right side high up it seemed more tender. There was no psoas spasm.

The catheterized urine showed strongly positive guaiac, 8-10 red blood

RUPTURE OF LIVER IN A CHILD FOLLOWING COASTING

cells to a field and a very definite ++ glucose reaction. Blood sugar as subsequently reported was normal, 1.03 gms. L. Temperature, 99.4; pulse, 100; respiration, 28; leucocytes, 27,000; polymorphonuclears, 80 per cent.; blood-pressure, 108/70; red blood cells, 4,400,000; hæmoglobin, 80 per cent. No bile present in blood serum.

At midnight, four hours later, leucocytes 22,000, polymorphonuclears 82 per cent. One A.M. vomited considerable stomach contents, felt better and went to sleep. It was then thought she might have a rupture of the kidney and retroperitoneal extravasation of blood and urine.

At nine the same morning the reporter first saw her and was told that though it had been decided to wait a few hours for more definite indications as to operation and where to operate, her condition was not as satisfactory as it had been hoped it might be. Temperature, 100.4; pulse, 110; respiration, 20; red blood cells, 3,500,000; hæmoglobin, 70 per cent. Chest was strapped; nothing definitely abnormal made out there. Didn't want to move because of pain in lower chest and upper abdomen. Abdomen was somewhat distended and slightly tender everywhere, especially on right side. Spasm corresponded. The costovertebral angle was not tender and she moved her legs freely. The rectal examination was very conclusive, a boggy mass in the cul de sac that was exquisitely tender. Chest and abdominal X-ray plates were negative.

Because of the signs of peritoneal irritation that had become evident, the abdomen was opened in the midline under novocain. About 400 c.c. of blood was sucked out from the peritoneal cavity. The rest of the operation was done under ethylene and oxygen. By extending the incision upward blood was found coming from the right upper abdomen and a tear could be felt in the right lobe of the liver. Spleen, kidneys, pancreas, gut, stomach and retroperitoneal spaces all appeared normal. A slightly oblique incision was then made below right costal margin. A ragged tear was found running horizontally across the greater part of the right lobe, with a mass of brownish-yellow fibrin about it. It readily admitted the finger tips. Two Mikulicz type of vaseline and iodoform gauze tampons were placed between the torn liver and the ribs, with small soft rubber tubes between. The middle wound was closed with chromic to the sheath and through-and-through silkworm gut tied on buttons. The inner part of the transverse wound was similarly closed.

There was a free discharge of bile for nearly a week after operation. On the ninth day under gas anæsthesia the packing was removed practically without bleeding. She went home thirty-one days after the operation, nine days ago. The bloody fluid in her peritoneal cavity contained bile pigment and showed no bacteriological growth. Her clinical recovery, except for a superficial spot where the drains had been, and some weakness, has been satisfactory considering the time elapsed.

Reasons for presentation of Case: 1. An example of serious visceral injury incidental to the apparently harmless sport of coasting down one of the little Central Park hills.

2. A child can walk a half mile with an extensive rupture of the liver:

3. Red blood cells appeared in five urine specimens during the first two days yet no gross nor other clinical evidence of kidney rupture was found. Possibly an intracapsular injury.

4. A definite glycosuria with normal blood sugar was found. A similar glycosuria has been found in other serious traumatic cases. These cases have interested Dr. L. Bauman, who is seeking further data and more cases before making an analysis as to its significance or pathogenesis. Occurring as it did in this case with a normal blood sugar it suggests a so-called renal type of glycosuria.

5. If, when the peritoneum had been opened under novocain, some of the bloody fluid had been examined at once for bile pigment, a procedure that would not have taken more than about five minutes, it might have contributed somewhat toward the diagnosis of liver or bile passage rupture, though probably not have materially altered the procedure.

ABDOMINAL CONTUSIONS ASSOCIATED WITH VISCERAL INJURY

DR. GEORGE E. BREWER read a paper with the above title.

DR. CHARLES N. DOWD said that he had recently had tabulated the cases of abdominal contusions at Roosevelt Hospital for the last few years. He was surprised to find how few of these cases had been operated on, and as this hospital is located in a neighborhood where there are many accidents, every day various people are brought in with injuries from automobiles, falling from heights, etc. The method of handling them has been, when the case needed operation, not to delay at all. There have been cases, however, where there was doubt whether operation was desirable and these have caused much anxiety. As they have recovered without operation, they cannot be classed as rupture of the liver, or spleen, for there is no proof, so they are listed as abdominal contusions. There was usually an autopsy performed on those that died so it was possible to put on the history, "Rupture of the Liver," or "Rupture of the Spleen." Consequently the hospital records do not give one an accurate idea of the real number of these cases of rupture of a solid viscus that have come in because so many have gotten well under the diagnosis of "Abdominal Contusions."

There are eleven of these tabulated cases of rupture of the liver and of the spleen gathered from the hospital records. Of that number there were seven deaths, which does not give much encouragement for operation. One case of splenectomy died immediately, two died after palliative operation, one not operated upon died. There were three other deaths, one after operation; so operation was done in four and the operation was of no avail in any of them. In the cases cured there was one hepatorrhaphy, repair of a small tear in the right lobe, but there was not more hemorrhage than is often seen in a gall-bladder operation where a small area of the liver is exposed. In another there was a little crack in the liver two inches long, and in another there was rupture of the spleen where only exploratory was done, and in another there was rupture of the kidney. These got well. Speaking from the records of the first surgical division of this hospital for the last few years (not very severe cases, but taking them as they come in) there had been little in the way of encouragement for operation. In the next few years the preponderance of cases may be those that need operation and will get well with it. But although watched with great care and operation done on all that needed operation, it would not seem that operation had been very encouraging in these cases.

DR. JOHN F. CONNORS said that in his experience at Harlem Hospital he was changing the methods of treatment in these cases of intra-abdominal injuries and that less operations are being performed. In many cases it is the

ABDOMINAL CONTUSIONS ASSOCIATED WITH VISCERAL INJURY

opening of the abdomen which decreases the intra-abdominal pressure and causes renewed hemorrhage when if the abdomen was allowed to remain closed and the intra-abdominal pressure not interfered with, bleeding would not recur. The attitude in these cases is much the same as that adopted in cases of fractured skulls. Operation was formerly done on all these cases and the mortality was high. Since stopping routine operation in these skull cases the mortality has been greatly reduced. Many cases of intra-abdominal injuries are operated upon too early and if they were observed for a while many less operations would be done and the end results would be better.

In the last year there have been quite a number of cases where there was blood in the urine, none of which came to operation, the urine cleared up, and the patients recovered. There have been cases in which there might have been a ruptured spleen, but of course there being no operation, diagnosis was made solely from the patient's condition and the blood picture. In none of these cases in which no operation was done was there a fatality.

DOCTOR CONNORS said that he had looked up the statistics at the hospital and found that from September 1, 1923 to April 1, 1924, fifteen cases were admitted to the hospital with a diagnosis of intra-abdominal injury. Of these, four cases were the results of falls; one patient fell four stories, there was ecchymosis on the left side, blood in the urine, patient was in shock, no operation, recovery. Of the four cases there was one operation, in which ruptured gut was found, patient died. In these four cases there was one operation, one death; three non-operative cases, three recoveries. Two cases were crushed, neither of which were operated upon, both recovered. Seven were struck by automobiles; two operative cases, one death; five non-operative cases, one death. There was one case in which the patient was coasting; blood in the urine, no operation, recovery. One patient was struck by a plank from a circular saw, operation, ruptured gut was found, recovery. Of the fifteen cases there were five operative cases with three deaths. There were ten non-operative cases with one death, which would seem to indicate that a policy of watchful waiting was giving the best results. Of course, in cases of ruptured intestine there can be but one method of treatment and that is immediate operation.

DR. JOHN DOUGLAS called attention to the trivial amount of trauma that sometimes results in great injury. He remembered four cases of solid viscus injury, after not very severe accidents, one a motorman who was struck by the backward swing of the brake on his car which caused a rupture of the kidney; another case was that of a small boy who was struck a glancing blow by an ice wagon with a result of rupture of the spleen, another a ruptured kidney following a fall from a bicycle and a ruptured liver following a fall from a wagon, the three last cases being children. As to the symptoms in these cases, it is not always possible to make a diagnosis. While rigidity and shifting dulness are the two best signs, it is difficult to differentiate the signs of hemorrhage from those of shock. Doctor Douglas had seen a woman lately who had been run over in the iliac region and was contused and black

and blue locally, and it was difficult to tell on examination which was voluntary rigidity from tenderness due to local injury and which involuntary rigidity from intraperitoneal hemorrhage. She had no pulse at the wrist, hæmoglobin was 70 per cent., and there were 4,000,000 red blood cells, and the extreme pallor, air hunger, and weak and rapid pulse seemed at first to indicate an internal hemorrhage.

The speaker had met with one case of retroperitoneal rupture of the duodenum. In this case there was infiltration from leakage down behind the ascending colon to the cæcum. If he had been operated on immediately it is doubtful if the lesion would have been found. As to the hemorrhage following the opening of the peritoneum, he had one case of ruptured liver that died almost immediately after the peritoneum was opened, although the pre-operative condition did not appear a desperate one. As far as rupture of the kidney is concerned, in which the kidney was sutured, he thought this procedure was rarely successful. He remembered one case in St. Luke's Hospital in which there was continued bleeding and the hæmaturia continued until the kidney had to be removed several days later. In addition to having transfusion ready to use at the time of operation, it is a help to leave in the abdomen every bit of blood possible, the same as in operation from a ruptured ectopic pregnancy and fill the peritoneal cavity up with saline before closure. He believed a considerable amount of blood is thus saved and absorbed back into the circulation.

DR. BENJAMIN T. TILTON said that he had seen a transverse fracture of the body of the pancreas produced by direct traumatism. The patient had been caught between a heavy trunk and the side of a baggage car. There was a large amount of blood in the lesser sac and the case terminated fatally from shock and hemorrhage. He thought it should be recognized that hemorrhage behind the peritoneum could give symptoms like those of an intra-peritoneal injury, such as marked tenderness, muscular rigidity and later peritoneal irritation. Such a condition should be thought of before deciding on operation for supposed visceral injury.

DR. HUGH AUCHINCLOSS said he did not consider an immediate operation harmful if a small incision was made and a local anæsthetic used. He thought it was not safe if an intraperitoneal injury were suspected to let it go. The operation can later be made more extensive if necessary.

DOCTOR BREWER, in closing the discussion, said he wanted to emphasize what Doctor Tilton said. He had seen large retroperitoneal extravasation simulate peritoneal irritation. An interesting case which he had not mentioned in his paper was that of a child brought in with a severe abdominal injury and indefinite symptoms. There were symptoms of considerable shock and an exploration was done and rupture of the pancreas was found. A large packing of gauze was put in and a cigarette drain surrounded by rubber tissue to bring about absorption of the pancreatic fluid as otherwise there would have been extensive fat necrosis.

THE ELECTRO-MAGNET-RADIATOR-VIBRATOR OF MÜLLER

Regarding conservative as opposed to the radical measures in these cases, there is ground for both views. There are many slight injuries that recover spontaneously, but one cannot know they are slight; as a rule they are severe.

The speaker could not agree with Doctor Connors as to letting all the kidney cases go without operation. In one of his cases, the kidney was torn in three pieces and it was doubtful if there would have been recovery without operation. Cases with enormous extravasation of urine would not recover. If a patient is pulseless, the color of white wax, has air hunger, and on opening the abdomen half a gallon of free blood escapes, that case will not recover without operation. If one in ten can be saved by timely operation in these severe injuries, this is doing pretty well. That type of case cannot be saved by conservatism.

Stated Meeting Held April 23, 1924

The President, DR. EUGENE H. POOL, in the Chair

THE ELECTRO-MAGNET-RADIATOR-VIBRATOR OF MÜLLER

DR. WILLIAM C. LUSK presented three patients who had been suffering from painful cicatrizing scars and a painful contusion, and who had been greatly benefited by treatment with the "electro-magnet-radiator-vibrator of Müller." He said that the quite remarkable properties of this device are but little known. The principle applied, which gave to the magnet its therapeutic value, was that the electrical energy should be furnished by the alternating current. The latter threw the magnetic field radiating from the instrument into a state of rapid oscillatory movement, which undoubtedly penetrated tissues placed within its influence. He used an alternating current which was generated by a rotary-transformer, the speed of revolution of whose armature increased with an increase in the strength of the current passed through the coil of the magnet, so that the number of cycles of alternation of the electric current per second varied from 63 to 73 in the range of strengths of currents used between seven and twenty-five ampères. For the latter two strengths of current, oscillatory motion was set up in the magnetic field at the rates of 7600 and 8800 oscillations, respectively, per minute. It had been thought that this variation in the cycles of alternation for different strengths of current passed through the coil of the magnet, might afford some explanation of the varying therapeutic effects exercised by the magnetic influence with the differing strengths of the electric current used. With the use of an alternating electric current generated by a rotary-transformer, a fifteen-ampère strength of current for the administration of radiation, had seemed to be the highest one advisable to employ. In the therapeutic administration of this radiating magnetic influence, the central spot of the magnet, near which the power of the magnetic attraction and the force of the oscillatory movement were greatest, should be placed directly over the site to be treated, which latter it was not necessary for the magnet to touch. The central spot of the magnet should be applied at intervals of about

two or three inches, generally for two minutes at each site. There were vibrators which, on being fixed to the end of the magnet, took up the oscillatory movement of the magnetic field. Radiation was usually applied to the tissues preceding the use of the vibrator. The vibrator had special uses and it was thought that it should best be applied only at intervals of a week or two or longer, in order to allow to take place a favorable reaction of the tissues, which it had seemed could then result following each use of it. A too frequent use of the vibrator had seemed often to intensify the symptoms for the relief of which it was being used. It should be applied with a thick cushion of flannel intervening between it and the tissues. Mr. Müller had cautioned against using it over the central nervous system. There was thought, as well, to be a reaction-time following each application, or several frequently-given applications, of radiation from the magnet, in which greater progress toward recovery of the tissues would take place if treatments were interrupted, than if they were continued to be given frequently. The speaker believed that this device afforded a new therapeusis for otherwise intractable painful cicatrizing conditions. The use of the magnet was illustrated by the history of the first case presented, which was as follows:

The patient was a physician, who on March 29, 1922, was given an injection of 1 c.c. of 80 per cent. alcohol, aimed through the mouth, at the right inferior dental nerve beneath the ramus of the jaw, and on the third day thereafter, no relief to the pain having resulted, a second similar injection was given into the same location and three days later the pain stopped. However, in about ten days more, the injected tissues had so contracted that the patient was unable to open his jaws wider than to attain a spread of about half an inch between his incisor teeth, and there was a quite severe boring pain on motion of the jaw, which continued up to the time of beginning treatments with the magnet on May 7, 1922. On this date he could separate his incisor teeth without pain only about $\frac{1}{8}$ inch, further opening of his mouth causing pain, the maximum spread between the incisor teeth being to an extent that would just admit the distal interphalangeal joint of his index finger. The ingestion of food was attended with so much pain that he would stop eating in the middle of his meals. The painful area on spreading the jaws was located just behind the right ramus, a little above the angle of the jaw.

Between May 7 and 17, the patient received ten treatments with radiation from the magnet, and at the end of this time he considered that he could open his jaws to within about $\frac{1}{4}$ inch of their normal spread, and there was no pain at all on strongly stretching the jaws apart to the limit of the restraint.

This result came about as follows: At the first treatment, immediately following two minutes of radiation over the seat of the pain, using 17 ampères, the patient said that the pain was about 50 per cent. relieved, after one minute more of radiation there was greater relief, and then after waiting for half an hour the patient was able to open his lower jaw to the limit of the obstruction practically without pain. The following morning, before treatment, the pain on spreading the jaws was as bad as ever, but the jaws could be opened distinctly wider than before. Radiation, using 17 ampères, was now administered over the seat of pain as well as over the right temporo-maxillary joint for two minutes apiece. On the third day, before treatment, the jaw could be opened nearly to the limit allowed by the restraint without

FRACTURE OF THE SURGICAL NECK OF THE HUMERUS

any pain, but at the limit the pain was as much as ever. The movement of the jaw had undoubtedly improved since the previous day. On the fourth day the patient reported less pain on eating. On this date the current was reduced to 12 ampères, which afterward became to be regarded as the correct strength of current for the treatment of a painful cicatrizing scar with radiation from the magnet, and soon the time of application of the radiation was established at three minutes over the temporo-maxillary joint and at four minutes over the angle of the jaw. Immediately following this treatment the pain caused by moving the jaw was controlled. On the fourth and the fifth days there seemed to be no increase in the spread between the incisor teeth. On the sixth day, on which no treatment was given, the patient was able to open his jaws to the limit with only slight pain, and on the seventh day, before his treatment, with no pain at all. On the latter date he was able to just get the proximal interphalangeal joint of his index finger through the spread between his incisor teeth. From now on, motion rapidly increased. On the eighth day he regarded that he could open his mouth $1/16$ of an inch wider than on the preceding day and about $1/4$ inch wider than he could before the magnet was used, and he thought that the effort to stretch the scar was not quite so painful as it had been. On the ninth day the patient reported that when he stretched his jaws widely he had only a little pain and that he was eating with perfect comfort. He thought the spread had increased a little since the day before. On the tenth day he had practically no pain on "ordinary" stretching of his jaws. On the eleventh day, May 17, he had no pain at all with strong stretching of his jaws. The spread between the incisor teeth now lacked only about $1/4$ inch of the normal amount and he regarded the pain at the seat of the alcohol injections as cured and the jaw limbered.

The patient was next seen on May 24, when the spread between the incisor teeth had increased and was pretty nearly normal and there was still no pain associated with movements of the jaw. On this date he had one more treatment with radiation, using 12 ampères for three or four minutes, applied a little below the angle of the jaw, given for an unpleasant sensation which existed at this situation. The patient was next seen on June 15, when the spread between the teeth was practically normal and he could still force his jaw widely open without pain.

Thus this crippling cicatrization with its attendant pain was rapidly overcome, and it had not recurred.

FRACTURE OF THE SURGICAL NECK OF THE HUMERUS

DR. ALFRED STILLMAN presented a man, aged twenty, who on October 18, 1923 was thrown from the running board of an automobile, hitting on his right arm and shoulder, fracturing the surgical neck of the humerus and displacing the shaft markedly toward the axilla. The next day he was seen in the Roosevelt Hospital Emergency Department, was X-rayed and put up in an aeroplane splint. The following day he was admitted to the hospital, put to bed and the fracture treated by suspension of the arm in abduction with traction by 10 pounds weight. After three days of traction an X-ray showed better position of the fragments but no reduction. On the fifth day ether was administered and a very fair reduction accomplished by manipulation. A further effort made three days later without ether added a little more to this reduction. Union was firm in three weeks. The arm was taken out of the apparatus on the twenty-sixth day and the patient discharged. Function has been complete from the day of his discharge and a few days ago he played baseball.

This patient was shown to demonstrate what a good reduction can some-

times be made in a badly displaced fracture, and the early return of function in these cases treated in the abduction position as compared with those treated with the arm at the side. The latter take several months to regain function.

DOCTOR STILLMAN presented also a girl, aged thirteen, who fell on a doorstep March 1 and fractured the surgical neck of the left humerus. She was put up in a Velpeau bandage in the Roosevelt Hospital Emergency Department. Two days later she was admitted to the hospital, put to bed, her arm suspended in abduction with traction. The position of the fracture was found to be unchanged and an effort was made to get her parents to give permission for a general anæsthetic to be given so manipulation could be tried. This permission was not obtained until the 13th and the attempted reduction was not successful. She was taken out of the apparatus March 31 and discharged April 6. Function was nearly complete. The effort at reduction was too late. She was shown for the result despite the decreased angle which the shaft makes with the head.

SUBGLENOID DISLOCATION OF THE HEAD OF THE HUMERUS WITH FRACTURE OF THE GREATER TUBEROSITY

DR. ALFRED STILLMAN presented a woman, aged fifty-two, who fell against a trunk March 26, dislocating her shoulder and tearing off the greater tuberosity of the humerus. Her X-ray shows the fragment well separated. The dislocation was reduced and this procedure also reduced the fracture. She was discharged with her arm in a sling. It is now five weeks and function is nowhere near as good as in the other two treated in abduction.

ANKLE FRACTURE

DR. JOHN C. A. GERSTER presented a stout man of sixty-two years, who sustained his injury on the night of February 17, 1924. The next day he was admitted to the service of Doctor Stetten at the Lenox Hill Hospital, with a fracture of the lower end of the fibula and of the tibia, the line of fracture running through the posterior part of the articular surface. There was marked backward displacement of the foot and leg with extreme swelling and ecchymosis. Two attempts at maintaining reduction in plaster having failed, a third attempt at reduction by suspension and moderate traction succeeded. A broad strip of adhesive was applied to sole and heel and kept in contact with the skin by a muslin bandage. To the free end of this adhesive, beyond the toes, a rope with eight pounds traction was sufficient to lift the foot clear of the bed. A Sinclair skate was then attached to the bandage covered foot and ankle by adhesive strips and covered by another bandage with six pounds traction applied to this. Reduction was immediately obtained and maintained. The Sinclair skate was removed within a few days but suspension was kept up for six weeks. After the first ten days' active flexion and extension of the ankle was begun. Total duration of stay in hospital was eight weeks.

The patient has about 30 per cent. of motion in ankle-joint at the present time and has resumed his former occupation as storekeeper. The difficulty in maintaining reduction was due to the fracture of the posterior part of articular surface of tibia which permitted the foot to slip backwards. The suspension of the foot made it possible for the weight of the leg to cause the unfractured anterior articular surface of tibia to move backward and assume its proper relationship with the articular surface of astragalus.

Slight eversion of foot was easily controlled by raising inner border of sole and heel $\frac{1}{4}$ inch.

LONGITUDINAL FRACTURE OF PATELLA

PLASTIC CLOSURE OF PERSISTENT THROUGH-AND-THROUGH SINUS OF LOWER THIGH

DR. JOHN C. A. GERSTER presented a girl, eighteen years of age, who at the age of five suffered from an acute osteomyelitis of the lower end of right femur which was operated upon in another hospital. She was under treatment for thirteen months. Ankylosis of right knee resulted. Was then free from symptoms until one year ago when abscess in the old scar developed, which was drained and then closed.

She was admitted to Mt. Sinai Hospital, September 24, 1924 (Service of Dr. A. A. Berg) with a history of pain over lower end of right thigh, with fever and sweats for three weeks. September 26 abscess was opened and drained by Dr. J. Stenbuck. The abscess extended up behind femur for 4 inches. Bone not definitely diseased. Scars over both internal and external aspect of thigh over lower end of femur excised and through-and-through drainage established. Fever subsided promptly, but sinus refused to close. Injection of Beck's paste on one side caused escape of paste through sinus opening on opposite side.

Operation, December 22, 1923. Excision of old scars on inner and outer sides of lower thigh down to level of femur, exposing normal soft parts of leg just above knee except for ring of scar tissue comprising sinus as it passed behind the bone just above condyles. This ring of scar tissue was large enough to permit index fingers—introduced from each side—to touch behind bone. Just behind this ring of scar tissue and intimately adherent to it could be felt the femoral artery. As the removal of this scar would have been extremely difficult and dangerous, it was decided to fill the retro-femoral part of the sinus with a pedicle flap of muscle. Such a flap was accordingly obtained from the vastus externus with base opposite sinus opening. Its free end was drawn through sinus without tension and was sutured to soft parts of inner wound. Both internal and external thigh wounds were partly closed with interrupted sutures and drained. The patient had a long but uneventful convalescence, was discharged from the hospital February 1, 1924. She has shown no signs of infection since then.

Her old osteomyelitis resulting in ankylosis of right knee with shortening over $1\frac{1}{2}$ inches produced a compensatory scoliosis.

DR. H. H. M. LYLE emphasized the value of muscle grafts for plugging sinus, bone cavities, etc. In his hands this method has given him far better results than fat grafts. Muscle grafts had succeeded in the head of the tibia, the condyles of the femur and in the humerus where fat grafts had been tried and failed.

LONGITUDINAL FRACTURE OF PATELLA

DR. JOHN C. A. GERSTER presented a woman of sixty-three who on April 5, 1923, was in the act of boarding a street car when someone stepped upon her skirt and she fell forcibly upon her right patella. A few hours later when first seen there was an effusion into the knee-joint, but no limitation of active or passive motion. Localized pain and tenderness over patella. X-ray showed longitudinal fissure fracture running through outer third of patella, with slight separation of fragments. The knee was kept at rest in a compression bandage for ten days, after which she walked with a cane and made complete recovery in ten weeks.

NEW YORK SURGICAL SOCIETY

MESENTERIC CYST CAUSING INTESTINAL OBSTRUCTION

DR. THOMAS ALLISON SMITH presented a girl from the Children's Surgical Service of Bellevue Hospital. Admitted January 21, 1919, age seven years. Six days before admission to the hospital she was taken sick with persistent vomiting, no food or liquid being retained. This condition continued up to the time of her admission. There was no pain. On the day following onset of symptoms her bowels moved thoroughly, but did not move again in spite of frequent purgatives. Examination showed a well-developed, but poorly nourished girl. Her abdomen was slightly distended, but there was no rigidity and only slight tenderness which was about one and one-half inches to the right and slightly below the umbilicus. Over the lumbar region posteriorly the muscles were rigid on the right side, and the child was very tender to fist percussion. Rectal examination revealed a mass in the right lower quadrant which seemed to be movable. Her temperature was 100, pulse 128. White blood cells 12,000, with 75 per cent. polymorphonuclears. Urine contained both albumin and acetone.

She was operated upon eighteen hours after admission, the operation revealing that there was a cyst of the mesentery producing an intestinal obstruction by twisting the bowel due to a slight rotation of this cyst. Because of the tightness of the obstruction due to the twist, it was thought best to excise this portion of the intestine, which was done, uniting the bowel by lateral anastomosis.

For the next two weeks this child's condition appeared to be very critical, with rapid pulse, abdominal distention, and fecal vomiting. She developed pressure sores over her occiput and back. Finally, on the fifteenth day, she developed a fecal fistula and from that time on, her condition improved. She was discharged at the end of seven weeks, and has had no abdominal complaints in the five years that have elapsed since her operation.

SUBCUTANEOUS LACERATION OF THE PANCREAS

DR. THOMAS ALLISON SMITH presented a boy from the Children's Surgical Service, Bellevue Hospital, age seven years. On the date of admission, March 29, 1918, the boy fell from a ladder a distance of about five or six feet, striking his abdomen and head. He was dazed for a few seconds, but was not unconscious, and walked into his house. About two hours later, he vomited clear fluid, and vomited again about an hour later, but complained of no pain except soreness under the left costal margin, where there was an abrasion of the skin and some ecchymosis. He also had signs of a contusion over his forehead.

Examination was negative except that his abdomen was rigid throughout and he had considerable tenderness on pressure, most marked midway between the umbilicus and the tip of the ensiform. His temperature was 99.6°, his pulse 96, white blood cells 18,000, 90 per cent. polymorphonuclears. Urine was negative except for a trace of albumin.

He was placed under close observation. During the night he vomited several times, and had some cough. During the next day, abdominal rigidity and tenderness increased, and the vomiting continued. For this reason, it was thought best to explore the abdomen, which was done about thirty hours after the injury. As soon as the abdomen was opened, there was found a small amount of blood-stained fluid. There were several small areas of fat necrosis in the gastrosplenic and gastrocolic omenta, also a tear about one inch in length in the gastrocolic omentum. This was enlarged, and the lesser peritoneal sac examined, which contained some bloody fluid and showed a

OSTEOCHONDROMA OF VERTEBRÆ

transverse tear in the tail of the pancreas about one inch in length and not more than one-eighth of an inch in depth. A cigarette drain was sutured to this tear and brought out through the gastrocolic omentum. No other abdominal injury was observed. For the next two weeks the wound drained very freely, the secretion digesting the skin about the wound. Within a day or two after the operation, his coughing and vomiting developed into a full-fledged whooping cough, which complicated the case and delayed healing. He was taken home by his parents thirty days after admission, with the wound still draining, but it was closed seven weeks from the date of injury.

DR. WILLIAM B. COLEY said that he had had one case of rupture of the pancreas, an airman who fell from a great height during the war. He was operated on and developed a fistula. This finally healed up and he made an excellent recovery.

DR. HERMANN FISCHER referred to a case of injury of the pancreas which he observed some ten years ago. A little girl had been run over by an automobile and was brought into the Lenox Hill Hospital severely shocked, with signs of intra-abdominal injury. The clinical signs pointed to an injury of the stomach, spleen, or pancreas. Laparotomy revealed a multitude of fat-necrotic areas in the large omentum. Stomach and spleen intact. On exposing the pancreas quite extensive fat necrosis in its vicinity was noted. The head and body of the gland was intact but its tail was crushed. A tampon was carefully adjusted around the injured portion; the bloody effusion which was present in the abdomen was removed by saline irrigation. The patient made an uneventful recovery.

DOCTOR SMITH's and the speaker's cases are interesting because of the fact that in both the tail of the pancreas was the only portion involved. In crushing injuries it is usually the body which is caught between the lumbar vertebræ and the injuring force. Injuring of the body and head are more common and dangerous than injuries to the tail because the ducts of pancreas may be torn in body injuries. In Doctor Smith's case the lack of shock immediately after the injury should be noted as unusual.

OSTEOCHONDROMA OF VERTEBRÆ

DR. CHARLES A. ELSBERG presented a patient from whom he had removed a large osteochondroma of the vertebræ which had caused marked spinal compression symptoms. There was a history of four months of pain in the lumbar spine and increasing loss of power in the lower extremities. Upon examination there was a large, hard palpable tumor over the lower back and marked disturbances in the power, reflexes and sensation in the lower extremities up to the level of the eleventh thoracic segment. The X-ray showed a large calcified mass in this region which was diagnosed as a benign growth. The operation, performed in February, 1924, consisted of an extensive laminectomy and excision of a large chondroma of the vertebræ that compressed the cord. The tumor was well limited, smooth and glossy in appearance and surrounded by a large amount of new bone. The tumor was found to have crowded the dural sac markedly to the right and was removed in pieces with a large amount of new-formed bone around it. The growth was gradually followed to the right side of the bodies of the vertebræ and removal of this portion of the growth was very difficult on account of its close connection with the pleura. Portions of the left eleventh and twelfth ribs and the transverse

process of the twelfth thoracic vertebra that were involved in the growth had to be resected, and although great care was taken in freeing the tumor from the pleura, a large rent was made in the pleura. The rent in the pleura was closed by a continuous suture and the wound then closed. The patient recovered very satisfactorily from the operation and has been improving steadily since that time. The pathological report was osteochondroma.

DR. WILLIAM B. COLEY asked Doctor Elsberg what his prognosis would be in this case. He was interested to know because he had seen similar cases pronounced chondroma by the pathologist which had later turned out to be malignant chondrosarcoma.

In answer to this question Doctor Elsberg replied that he considered the prognosis to be very good. The tumor was a benign one and was entirely removed. He thought the chances for recurrence were small. Although the patient still had a number of spinal symptoms, it was too soon after operation for them to have disappeared and they could be disregarded in making the prognosis. He had had two other cases of osteochondroma of the vertebra, although in neither was the growth as large as in this case, and both had been well for five years.

FRACTURES ABOUT THE UPPER END OF THE HUMERUS

DR. HAROLD SANTEE read a paper with the above title, for which see ANNALS OF SURGERY, July, 1924, vol. lxxx, p. 103.

DR. H. H. M. LYLE said that in looking up the history of his suspension frame (erroneously called the Balkan) he had found reference to this method as far back as 1812. The choice of the methods to be used depends on the amount of flexion, abduction and external rotation of the upper fragment. In the simple cases it is quite possible under ether to bring the lower fragment in line with the upper, to engage the ends and bring the arm down into mild adduction and maintain this position by weights or traction. Good functional results can be obtained without confining the patient to bed. If the relation of the parts cannot be maintained by these simple means, then the Whitman abduction shoulder spica or some form of platform splint embodying these principles should be used. These methods give excellent functional results and do not confine the patient to bed. There is another group of cases in which it will be necessary to use the suspension traction method as described in Doctor Santee's paper. This method has the practical disadvantage of confining the patient to bed for a period of three to four weeks. It is the method of choice in compound fractures and in gunshot wounds of the shoulder.

In the cases associated with dislocation of the head, every attempt should be made to reduce the head by—first, manipulations, and second, operative means. The head should never be removed only in exceptional cases. The results of excision of the head are uniformly poor and often disastrous. This statement holds good both for military and civil surgery. In a few cases the dislocated head can be left *in situ* and a good functional result obtained.

FRACTURES ABOUT THE UPPER END OF THE HUMERUS

DR. JAMES N. WORCESTER spoke of the extent of the disability in simple fractures of the humerus which was out of proportion, often, to the anatomical difficulty; and when the latter was added the problem was worse. The thing to do was to bring the complicated cases into the position of a simple fracture by operation or otherwise. A marked feature was the pain of these fractures which made difficult the attempt to get return of function. If abduction and rotation were maintained from the start, this pain was absent. The speaker believed that impaction of the head of the humerus occurred after the original fracture had taken place and this explained the difficulty of regaining external rotation. Resection of the head should be avoided in every fracture of the upper end of the humerus at all costs.

DR. ROYAL WHITMAN said that he had been pleased to learn from the discussion of the practical acceptance of abduction as the position of election for fractures with displacement, because many years ago he had called attention to the analogy of the hip and shoulder joints from the therapeutic standpoint. It was evident that the practically complete restoration of function in the cases presented, treated by immediate reduction and fixation, as well as in those treated by traction in bed, in spite of the fact that the alignment was not always satisfactory, was to be explained by the abducted attitude which prevented the restriction of movement that so often persisted when the fracture had been treated in the ordinary manner.

In the ANNALS OF SURGERY for May, 1908, he had described the abduction treatment by means of the shoulder spica and in particular a method of reducing and fixing epiphyseal fractures with the typical displacement of the shaft forward and upward, for which at that time there was no effective remedy, and which applied to similar fractures in older subjects. Manual traction was made upon the arm directly upward, thus rotating the scapula and bringing the axilla into lateral relief, so that by leverage of the shaft on the acromion and direct manipulation of the head, the fragment might be apposed. The arm was then fixed in this upright attitude with the forearm flexed over the head, and as the glenoid surface of the joint was in this attitude almost horizontal the force of gravity acting on the shaft apposed to the underlying head assured security.

He preferred to treat patients whenever practicable by the immediate reduction of the deformity and fixation rather than to divide the responsibility with assistants, which was one of the inevitable drawbacks of the traction treatment.

DR. JOHN F. CONNORS said that he thought his results from the use of the Thomas splint in these cases during the past two years led him to believe that these cases did very well. He attributed it to the fact that they became ambulatory cases sooner than the cases treated by the method of Doctor Santee. He agreed with Doctor Santee in regard to the so-called impacted fracture around the neck of the humerus and that in a great number of these cases that too much time was devoted in attempting to obtain a too good anatomical result, because if there is one class of fractures that needs motion

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it is this class and the sooner the motion is begun the better will be the ultimate result. In reference to the operation for resection of the head of the humerus in these fractures our results have been much as described by Doctor Santee, and he believes that the operation was rarely indicated, for however poor the anatomical result in these cases, they seem to do better than the cases in which the head had been removed.

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THE DIAGNOSTIC VALUE AND INTERPRETATION OF CEREBRO-SPINAL DETERMINATIONS*

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FROM THE NEURO-SURGICAL CLINIC OF DR. CHARLES H. FRAZIER, UNIVERSITY HOSPITAL

I. SPINAL PUNCTURE

THE procedure of lumbar, or spinal, puncture has become almost a constant necessity for correctly determining diagnosis and in the treatment of certain diseases. It is, however, not without danger and three of the foremost causes for many of the fatalities reported are:

1. *Meningitis*, due to the introduction of some pyogenic organism at the time of puncture.

Such a case has recently been treated on the medical service of the University Hospital. The patient (A. B.) had been punctured elsewhere 14 days previously. Soon after, he developed typical signs of a purulent meningitis, and was admitted to this hospital in a stuporous condition with a positive Kernig's sign, leucocytosis, fever, marked rigidity of the neck and a history of previous spinal puncture. Lumbar puncture showed purulent fluid; cisternal puncture also showed a cloudy fluid. Following a lavage with normal saline solution of the basal cistern and washing out of the spinal column, the patient regained consciousness within a few hours and appeared to be brighter. Doctor Piper's method of intravenous mercurochrome administration was resorted to, with the result that after three injections, the temperature returned to normal and the man's life was spared. He is now becoming ambulatory and will soon be discharged from the service.

Cultures from the lumbar and cisternal regions constantly showed *staphylococcus aureus* to be present.

Therefore careful preparation of the skin should be undertaken. Alcohol in itself is not sufficient and gloves should be worn to prevent possible contamination. Some solution, such as iodine or picric acid, should also be employed to obviate this danger.

2. The second source of danger lies in the variable pressure factors which may be present. A point which cannot be too strongly emphasized is the determination of pressure in every instance. If the case warrants spinal puncture, pressure values are always important. This should be done with an approved type of manometer. In cases where the pressure is above 18 mm. of Hg., when the patient is recumbent, no fluid should be withdrawn until the pressure can be further reduced by other means (dehydration). The many cases of sudden death reported following lumbar puncture (and just as

* Read before the Philadelphia Academy of Surgery, April 7, 1924.

many, if not more, that are never reported) are usually due to increased intracranial pressure too often unrecognized; and to the withdrawal of large amounts of fluid in these cases. With the escape of fluid from the spinal needle, the ventricular pressure within the brain above forces down the structures at the base so that the cerebellum may be jammed into the foramen magnum causing a "foraminal cone" or hernia. Depression of the respiratory and cardiac functions ensue and sudden death may occur. One cannot safely make a study of cerebrospinal fluid without a manometer any more than one can intelligently treat a case of fever without a thermometer.

3. The third source of danger is, although rare, indeed a real one and perhaps is the cause of more delayed, undetermined deaths than any other.

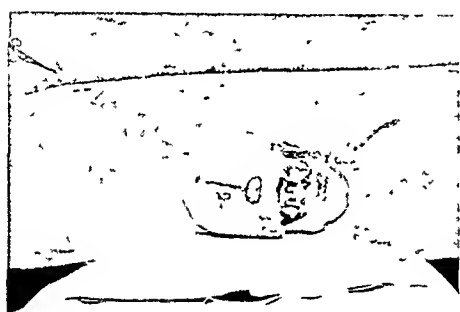


FIG. 1.—Posterior aspect of the skull. 1. Occipital protuberance. 2. Distance from the midline (marked with an X) for trephine opening.

This is due to thecal tears by the use of large needles which leave rents in the dura after their withdrawal. It is obvious that when cerebrospinal pressure is increased, a tear in the dura allows the fluid to escape unbeknown to the physician or patient. This fluid finds its way into the sacral area which is capable of holding 40 to 60 c.c., hence foraminal hernia may develop a few hours after lumbar puncture, where pressure is increased, even though no fluid has been removed at the time of puncture. Therefore, it is wise to use fine needles so constructed that the danger of breaking off is negligible. We have in the

Labat spinal needle a French nickeloid steel, an ideal instrument for spinal puncture. The Lewisohn needle has many advantages in that it is attachable to a manometer and has a tap cock which allows no escape of fluid but immediate pressure readings. It is further constructed so as to give a glass barrel to a portion of the needle which allows the operator to see the presence of fluid as soon as the puncture has been successfully completed.

Ayer, who uses a spinal fluid manometer consisting of a glass tube connected at right angles to the needles, reads his pressure by the rise of fluid in the glass tubing (mm. of hydrostatic pressure). He has even gone so far as to inject a small amount of horse serum following lumbar puncture, in order to facilitate coagulation around the thecal tear made by introducing the needle through the dura. This refinement in technic is not always necessary, but shows to what extent Doctor Ayer regards the gravity of thecal tears in the presence of increased intracranial pressure.

Pathologic Fluids Obtained.—A brief summary of the types of fluids seen under various conditions consists of:

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1. *Cloudy*.—(Opalescent to purulent) found in meningitis and irritative conditions of the cord and meninges.

2. *Hemorrhagic*.—(a) This may be of local origin and due to puncture of a small dural or arachnoid vessel. Usually the fluid becomes clear and, if the first few drops are compared with the next few, a difference in color will establish this fact.

(b) Remote hemorrhages usually show uniformly bloody spinal fluid which upon centrifuging leaves a yellowish supernatant fluid. The condition is found in cortical injuries due to contusion or laceration, and in fracture of the skull, injury to the cord, spontaneous hemorrhage, etc. Hemorrhages in the cortex and into the ventricles may also show blood in the spinal fluid following certain types of hæmoplegia. It is, therefore, often a useful diagnostic test for differentiating thromboses from hemorrhage.

In a recent paper, by Sharpe,[†] 6 per cent. of apparently normal deliveries, spinal fluid taken from the infant a few hours later showed blood due to some cranial injury. Repeated punctures should be made in these cases and fluid withdrawn each day until it becomes clear.

3. *Xanthochromia*.—(a) In old hemorrhages, the fluid will be found clear and, upon standing, does not coagulate.

(b) Rapid coagulation and a yellowish fluid are known as *Froin's syndrome*, and indicates a tumor of the cord or meninges, or a complete block in the spinal canal.

(c) Jaundice may cause a yellowish fluid which has no significance in the presence of either clinical signs or other hepatic disturbances.

Tests and Their Practical Values.—A brief summary of only the practical test for differential diagnosis is here given. (Many established and complicated determinations may be made, but these are only possible in conjunction with a well-equipped laboratory and hence are not easily available to the surgeon or general practitioner.)

1. The valued Wassermann reaction need not be discussed.
2. The colloidal gold determination is of great importance and curves obtained from this reaction may be of great value in assisting to definitely diagnose certain conditions. The colloidal gold reaction should *not* be considered as purely a test for syphilis, for many conditions give characteristic curves which are quite different from those found in tabes, or paresis. One should emphasize to the laboratory technician that a report of whatever

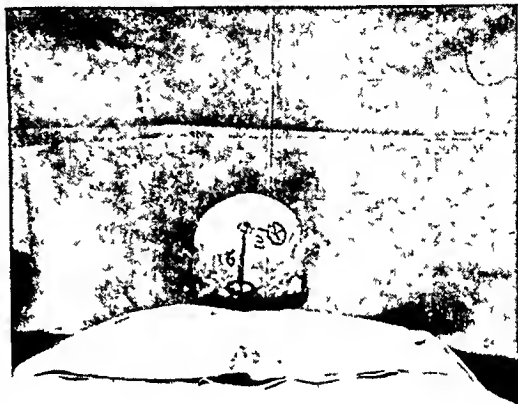


FIG. 2.—Posterior aspect of the skull showing measurements. 1. Six cm. from the occipital protuberance toward the vertex. 2. A distance of 3 cm. from the midline to the right or left depending upon the ventricle to be entered.

[†] Sharpe and Maclaire: Surg. Gyn. and Obst., vol. xxxviii, p. 200, Feb., 1924.

TABLE I.
*Cytological and Chemical Findings.**

Disease	Sugar			Albumin			Cells			
	Absent	Normal	Increased	Absent	Normal	Increased	Lymphos.	Polys.	Both	Spec.
Meningomyelitis: Tuberculous..... Syphilitic.....	— Reduced					+++ +++ +++ +++	+++ +++ +++ +++	+		
Meningitis: Acute..... Chronic.....	Absent Reduced					+++ +++ +++	+	+++ +++ +++ +++		
Tuberculosis: Acute..... Chronic.....	Reduced —					+++ +++ +++ +++ +++	+++ +++ +++ +++ +++	++	Yes	
Poliomyelitis..... Progressive poliomyelitis ..		✓				Trace to ++	+++ +++ +++	++ ++	Yes Yes	
Tabes.....	Reduced					++	++			
Paresis.....	Reduced					+++ +++ +++	+++ +++ +++			
Chorea.....		✓			✓		+	+		

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Herpes.....	✓		✓		+				
Mumps.....	✓		✓		+				
Leukemia					+				
Tumor of the cord.....	Usually ✓			+++++ Clots	+	Few		Tumor cells.	
Tumor of the Brain..... Glioma.....	Usually ✓			Usually increased	++			Tumor cells.	
Yeast.....								Yeast cells.	
Cysticercus infection.....					+			Eosin- ophils.	
In general: Acute infections..... Chronic infections.....		Absent Reduced		+ to + + + +	++ ++ ++ +				
Encephalitis.....				✓ or a trace	+				
Diabetes.....									

* This table revised and corrected by the kind assistance of Dr. John A. Kolmer.

curve found should be returned and not simply the statement that it is luetic or non-luetic, as is so frequently the case. The following groups, as they occur in the chart for colloidal gold reduction, reading from left to right (that is, in the lower dilutions and intense color of red toward the higher dilutions and the range of color to white), we find:

- (a) General paralysis of the insane (paresis).
- (b) Cerebrospinal syphilis, or tabes.
- (c) Anterior poliomyelitis.
- (d) Tuberculous meningitis.
- (e) Purulent meningitis, including brain abscesses.

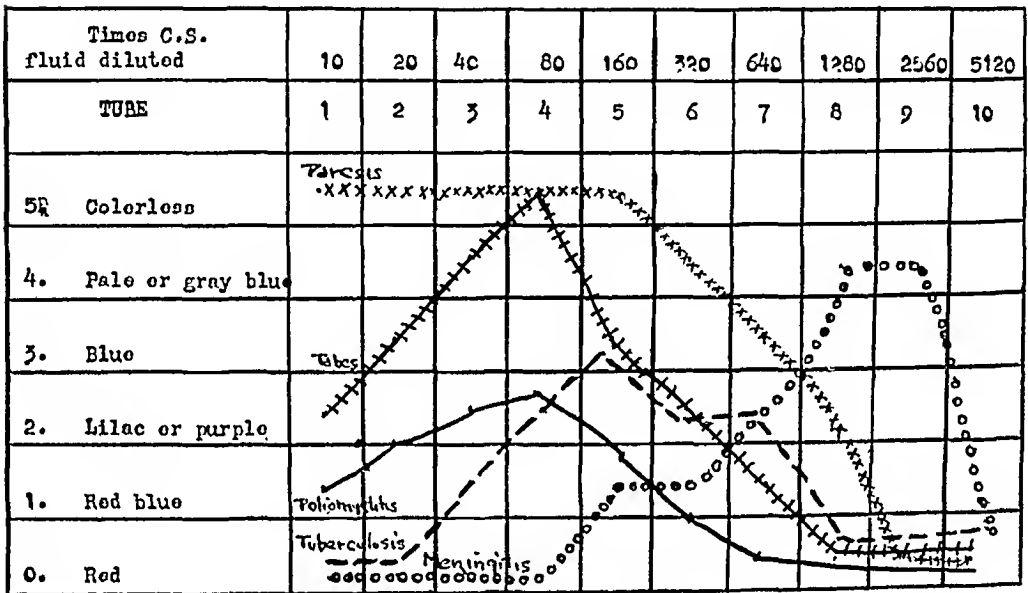


FIG. 3.—Colloidal gold curves. (After Regan and Cheney.)

So often blood-stained spinal fluid is said to vitiate colloidal gold readings, but it should be borne in mind that the presence of blood plasma in the spinal fluid will give a curve similar to that found in tuberculous meningitis and should not greatly interfere with the reading for paresis and tabes. It is evident that curves for the other conditions, when substantiated by clinical manifestations, are of great importance in determining the injury or disease of the brain and spinal cord.

Chemical and Cytological Findings.—The table on pages 644 and 645 has been constructed for easy reference and in general holds good in the following diseases.

Bacteriological Findings.—The following organisms may appear in the spinal fluid and should be looked for in cases where indicated. 1. Tubercle bacillus. 2. Typhoid bacillus. 3. Pneumococcus. 4. Diplococcus, intracellularis. 5. Anthrax bacillus. 6. Streptococcus. 7. Staphylococcus. 8. Yeast cells. 9. Tumor cells. 10. Trypanosomes.

II. SPINAL DRAINAGE

This procedure has been advocated in cases of intracranial injuries following childbirth where bloody cerebrospinal fluid is obtained.‡ Repeated drainage should be maintained until the fluid becomes clear. Cases in which hemorrhagic fluids are obtained following intracranial injuries or fracture of the skull after infancy usually do best when drainage is not instituted. Spinal drainage has been found of value in sunstroke, migraine, uræmic coma, puerperal eclampsia and purulent meningitis. In some cases of increase in intracranial tension, due to meningitis about the base of the brain, or brain tumor, it must be borne in mind that there is great danger in producing foraminal hernia and sudden death if much fluid is removed. The safer procedure would be ventricular puncture but, if this is not feasible, then fluid may be withdrawn from the lumbar needle after careful determinations of the initial pressure, and never allowing pressure to fall more than 5 or 10 mm. of Hg. at one time. Small amounts of fluid may be repeatedly withdrawn but always there is the source of danger above mentioned. Spinal drainage may be resorted to in cases where antiluetic treatment has been administered. (Swift-Ellis treatment.)



FIG. 4.—Point of entry into the brain showing the needle in place.

The patient should be placed on the face, with the feet elevated to avoid danger of cerebellar foraminal hernia. Serums and medications which are desired may be administered after the canal has been drained. These will be discussed under cisternal puncture.

III. THE QUECKENSTEDT TEST

This test is of value in determining spinal block and has been emphasized by Ayer, Cushing, and Mixter. It consists in compression of the jugular veins of the neck in such a way as to obstruct the outflow from the cranial cavity and thus increase congestion of the brain, causing a rapid transitory rise in pressure which is manifested not only by cyanosis of the face, but a subjective feeling of fullness in the head and, of course by spinal manometer where no obstruction between the ventricles and the base of the cord exist. Two other advantages arise from this test; namely a true determination of pressure showing the manometer to be accurate regarding the initial rise. A return to the former reading by the manometer usually occurs within a few moments. The column of mercury rapidly receding to its former level. Second, fluid may be obtained in cases where "a dry tap" sometime has failed to yield fluid. If the needle be properly in

‡ Sharpe, etc., *Loc. Cit.*

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place, jugular pressure will force fluid from it, and this has occurred in several instances where "a dry tap" was thought to have been present.

If obstruction occurs between the fourth ventricle and the base of the cord, due to tumor, fracture, dislocation, caries, exudate or pachymeningitis, it will be found usually that the initial reading is low (4-6 mm. Hg.). When the Queckenstedt test is applied, the rise of pressure, as recorded by the spinal manometer, is gradual and slow and never prompt. It is difficult to get readings as high as 20 mm. Hg. if the initial reading was subnormal (below 8 mm. Hg.).

After jugular constriction has been relieved, the fall to normal is very slow and a mean point may be reached where no further fall occurs. It is, therefore, of value in determining spinal block, but does not, of course, indicate the level of the lesion—other examinations must reveal this.

IV. LIPOIDAL INJECTION

The use of an opaque substance, such as lipoidal, in the spinal canal has been advocated by Sincard,§ using an emulsion of iodine and potassium iodide in a heavy oil. He found this substance when introduced into the spinal canal, could be easily moved about by change in posture and in cases of tumor, or obstruction of the canal, the substance came to rest at a definite point which would then be determined by X-ray studies as the substance throws a heavy shadow distinct from any normal X-ray shadow of the vertebræ. This method was tried for the first time in this clinic last October. In one case, an old fracture-dislocation of the spine, there developed such intense signs of root irritation following injection that the procedure has been regarded as very limited in its application.

V. SPINAL ANÆSTHESIA

This subject is so diverse and specialized in its application that no attempt will be made to outline the procedure.

VI. CISTERNAL PUNCTURE

This operation of introducing a needle into the basal cistern has a limited application but, when indicated, is one of our most dependable means of obtaining certain information and results. It should be borne in mind that cisternal puncture, although less difficult than lumbar puncture, is not without added dangers due to the proximity of the medulla and the vital centres. It

§ Sicard's method was to place the patient in the sitting posture and make the injection of the opaque substance into the Cisterna Magna—after injection, the patient was generously thumped on the back and X-rays taken in the sitting posture showed the arrest of the substance above the point of obstruction.

The possibilities of its use suggest themselves as a means of differential diagnosis but one must bear in mind the possible irritative effects, the fact that the substance behaves much like quicksilver and cannot be recovered again and also its slow absorption characteristics are to be seriously considered.

Since the case above mentioned, several other observations have been entirely satisfactory.

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should never be attempted in cases where increase in intracranial pressure is found or suspected, because intense pressure from above, due to ventricular obstruction, may force the cerebellar hemispheres into the foramen magnum and the entering needle produce a cortical laceration with hemorrhage and possible disaster in the outcome of the case. There should be a "stop" or check on the needle so that it is not allowed to slip beyond the point of dural penetration, else the vital structures of the cord may suffer. Its indications, however, are quite clear cut in determining spinal block and in certain types of medication. Where cord tumor, spinal

caries, subluxation due to trauma with pressure on the cord is suspected and a consequent "spinal block," a needle is first introduced into the lumbar region and pressure readings obtained by manometer. Another needle, with a separate manometer attached, is then introduced into the basal cistern. The Queckenstedt test, as above described, will determine the presence or absence of a spinal block by observing the response in the spinal needle, comparing its variation with that of the cistern—they should be alike in normal subjects. The presence of a block is manifested by a rapid rise in the cisternal needle, the pressure reaching 20 to 30 mm.

of Hg. upon jugular compression. If the spinal block be present, however, the lumbar needle may not register any increase of pressure or perhaps only a gradual rise which always lags behind that seen in the cisternal manometer and when jugular compression has been released, that rapid fall in the cisternal manometer precedes any change recorded from below by the registering pressure in the lumbar region. In case of block, this is quite marked and unmistakable in its significance. By using the height of spinal fluid pressure itself, as advocated by Ayer, where a glass tube is connected at right angles to the needle, respiratory fluctuations may be noted in one or both areas and even the pulse wave may be transmitted. Such delicate manifestations are at once obliterated in the lumbar manometer when some obstruction of the canal occurs between the base of the brain and the lumbar region. This test, of course, does not indicate the level of the lesions. A similar combination of ventricular puncture with a needle placed in one or both ventricles and a cisternal needle registering pressure may help to determine the presence of ventricular block. Phenolphthalein or indigo carmine injected into the ventricular needle may be obtained from the cisternal needle within a few moments if no obstruction exists.

The use of the cisternal puncture for therapeutic means has a definite



FIG. 5.—Cisternal puncture, showing the direction of the needle and its relation to the occipital protuberance and the foramen magnum.

value. Lavage of the cistern and the spinal cord may be obtained in cases of meningitis. Washing through the entire length of the cord by normal saline solution is especially effective in purulent meningitis. Medication may be introduced for lues (blood plasma following intravenous injection and centrifuging may be reinjected through the cisternal needle); specific serums may be introduced for epidemic cerebrospinal meningitis, tetanus, pneumococcus, staphylococcus, etc. Antiseptics, such as mercurochrome 1 per cent.,

is sometimes used in cases of tetanus and sedatives such as bromides in delirium tremens with beneficial results.¶

VII. VENTRICULAR PUNCTURE

This procedure has been much discussed by Dandy, Grant and others, and consists in introducing a Cotton cannula into the posterior horn of the lateral ventricle. Intracranial pressure may be determined: the size and shape of the ventricles may be shown by X-ray studies after the introduction of air to replace the fluid withdrawn. Ventricular estimation to determine the size of the ventricle by the amount of fluid obtained and in order to test for a block between the lateral ventricle and the opening of the

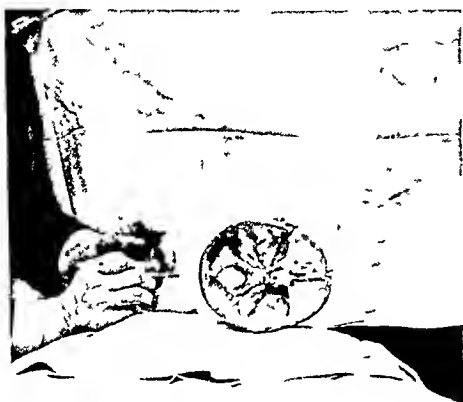


FIG. 6.—Anterior aspect of the skull. Needle in place for cisternal puncture. Note the "stop" on the shaft of the needle, consisting of a safety tie pin clasp to prevent its introduction beyond the dura after its insertion. The point of the needle will be seen just entering the foramen magnum.

aqueduct of Sylvius at the base, as described above by means of certain dyes, recoverable in the lumbar or cisternal fluids, and noting the time required for appearance of the colored liquid from the cisternal or lumbar needles. Perhaps one of its most valuable indications is the rapid means for relief of intracranial tension. Cases following acute injuries to the brain with the temporary increase in pressure, where the shocked condition of the patient prohibits dehydration, may be carried over this initial period of transitory pressure increase by ventricular puncture which is far easier to accomplish and less shocking to the patient than supratemporal decompression, and in skilled hands almost without danger. Several instances have arisen on the neuro-surgical service in which sudden respiratory failure occurred due to intense increase in intracranial pressure. The heart maintained its activity over a period of several minutes, ventricular tap relieved the pressure so that respiratory function was again established.

The subject of ventriculography has only special application and significance as an aid in the localization of brain tumors, and has been highly developed in the hands of Doctor Grant here in Philadelphia. X-ray pictures of the ventricles, filled with air, are of great assistance in determining the

¶ Purvis, Stewart: The Diagnosis of Nervous Diseases; Edward Arnold, London.

CEREBRO-SPINAL DETERMINATIONS

size and location of certain types of brain tumors. Ventriculoscopy has been attempted and photographs obtained of ventricles of the brain in a hydrocephalic child by means of a photographic cystoscope. It is possible, in the presence of enlarged ventricles, such as those seen in hydrocephalus and in tumors which obstruct the ventricular system causing intracranial pressure, to view the inside of the ventricle by means of a No. 10 cystoscope introduced in the same way as the Cotton cannula for ventricular puncture.

SUMMARY

We may, therefore, say that much of practical value may be obtained by spinal, cisternal and ventricular punctures; always undertaking these operations with the aid of a manometer, carefully noting pressure conditions as they exist and studying the fluid conditions for its various pathological conditions. It affords a direct means of medication to the spinal canal where indicated.

THE MECHANISM OF POST-OPERATIVE HEMORRHAGE

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IN THE present state of our knowledge, drainage by one means or another—rubber and glass tubes, rubber dam, gauze, etc.—is a necessary and important factor in practical surgery. The chief danger of drainage, especially when tubes are employed, is hemorrhage and discussion about the various ways of accomplishing drainage rests chiefly on, and centres about a method which is least likely to be followed by secondary hemorrhage. Secondary hemorrhage is especially important in abdominal surgery for the reason that opportunity for the bleeding to remain hidden is frequently present and the condition of the patient may reach a very precarious state before measures can be instituted for the ligation of the bleeding vessel. Indeed, if one considers the large number of cases of intra-abdominal disease which, after laparotomy, must necessarily be drained and in whom the drainage apparatus must of necessity lie in close proximity to a large artery or vein, it seems surprising that so few cases of secondary hemorrhage are encountered.

It is quite probable that the number of such cases of secondary hemorrhage is fairly numerous. However, the literature contains comparatively few recorded instances. Such accidents are reported by Torrance, White, Skerington, Corber, and Ward. Beyond the mere mention of the fact of secondary hemorrhage no one of these reports contains any information which would point out the reasons for the post-operative bleeding. Karpeles in reporting such a case says that: "Secondary hemorrhage is caused by a purulent periarteritis, arterionecrosis taking place. The drainage media, the pus, and the sutures are important factors."

Phifer's report contains the above-mentioned cases. Phifer includes these among other cases in which the secondary bleeding was due to other causes and occurred in the stomach, duodenum, etc.

In Moschcowitz's (1908) case the secondary hemorrhage had followed the withdrawal of rubber drainage tubes inserted at the close of an extraperitoneal operation for the removal of bilateral ureteral calculi; the wounds are described as having "healed by primary union." The importance of this case lies in the fact that owing to the nature of the operation no peritoneum intervened between the drainage tube and the external iliac arteries from which the bleeding occurred. Because of this fact Moschcowitz was led to believe at that time that hemorrhage could not ever occur if the blood-vessel was protected by an intact covering of healthy peritoneum.

We give herewith the notes of several cases in which this accident occurred:

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CASE I.—Hospital No. 227512. The patient, a boy of sixteen years, was admitted to the hospital on February 18, 1923 as an ordinary case of acute appendicitis with spreading peritonitis. For six days prior to admission the patient had had a sore throat and had complained of headache, anorexia, lassitude, fever and chilly sensations. Three days before admission to the hospital he was seized with severe pain in the left upper quadrant of the abdomen, accompanied by fever and vomiting. The next day the pain moved to the right lower quadrant of the abdomen where it persisted.

Upon examination there were found the usual signs of an acute intra-abdominal lesion in the right lower quadrant, rigidity of the abdominal wall, and tenderness both direct and rebound. Evidences of the sore throat—marked injection of the pharynx and tonsils—were still present.

Operation was performed immediately under gas-ether anaesthesia. The appendix showed extreme congestion with a sharp line of demarcation indicating thrombosis of the mesenteric lumen. The peritoneum was markedly injected in the general region of the operation and as far as one could see. Considerable peritoneal exudate was present from which the bacillus coli communis was later grown in pure culture. The appendix removed and stump cauterized with carbolic acid. Two moderately stiff rubber tubes were inserted for drainage; one of these extended to the pelvis; the other was laid in the right lumbar gutter.

The patient made a satisfactory immediate recovery from the operation. Later the temperature rose from 102° F. to 104° F. and signs of localized consolidation in the right lung appeared on the second day. With the temperature going to 106° F. on the third day, the patient became irrational and pulled out both of the drainage tubes. One of these was immediately replaced in the wound, but it was impossible to be sure whether this occupied its original site, or even to determine its exact position particularly with reference to its proximity to the large pelvic vessels. In spite of the fact that during the next day or so there was a profuse discharge of pus through the replaced drainage tube, the patient's temperature continued around 106° F. On the fifth day he again pulled the tube out—and again it was replaced.

Four days later (nine days after the operation), bright blood was suddenly discovered to be oozing through the dressings. The patient was immediately brought to the operating room, the tube was removed and the old incision was extended for about a half inch in each direction. The presenting intestines were packed away and a large vessel, apparently the external iliac artery, was seen spurting blood into the wound. The bleeding was controlled by pressure with one finger and the vessel was isolated above and below the bleeding point. Stout catgut ligatures were passed

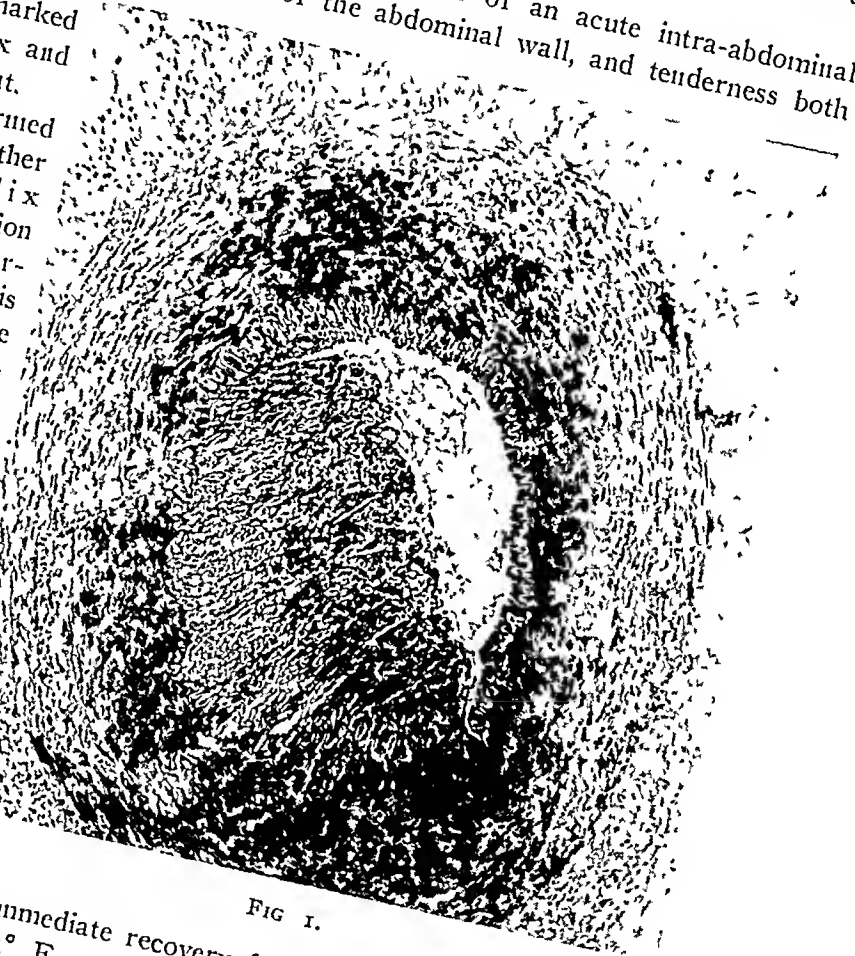


FIG. 1.

above and below and the vessel was tied on either side. A large tube was inserted into the wound and down into the pelvis.

At the end of the operation the right leg was found to be slightly congested and the pulsation of the dorsalis pedis artery of that side could not be felt.

Immediately after the operation the patient received an intravenous infusion of 600 c.c. of saline and a blood transfusion of about 250 c.c. In spite of these procedures, however, his pulse gradually became weaker and he died a few minutes later.

The post-mortem examination showed the following.

There was moderate distention of the abdomen. On opening the peritoneal cavity the

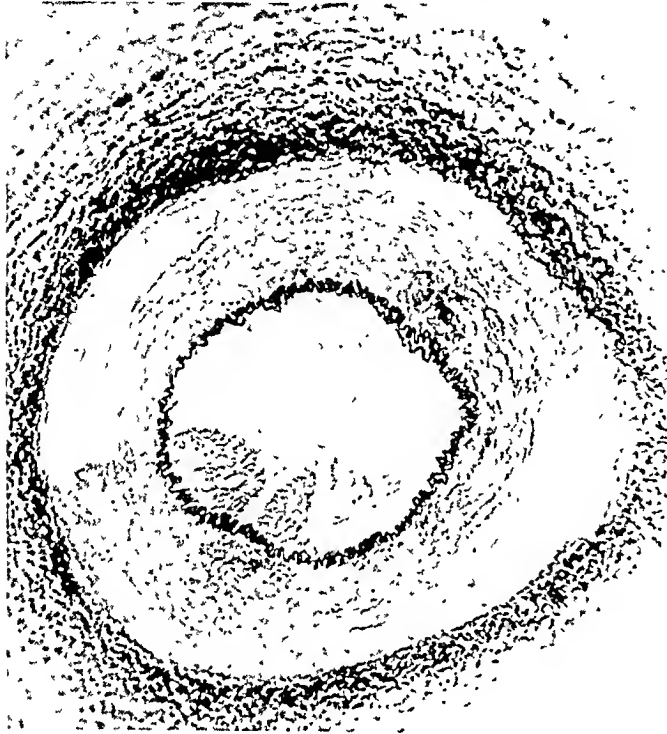


FIG. 2.

intestines were found to be markedly distended and covered everywhere with a thin fibrino-purulent exudate. There was a collection of pus in the right lumbar gutter. The omentum was firmly adherent to the cæcum. The appendix stump was exposed by separating the adherent omentum. The ligature with which the appendix had been tied at the operation was not found and there was a small round opening into the cæcum corresponding to the point of attachment of the appendix. There was, however, no fecal leakage. The recently placed drainage tube passed close to the rim of the pelvis and in close proximity to the external iliac vessel. It passed directly down to the rectovesical pouch, which contained a large amount of pus.

The right external iliac artery had been ligated in two places about a half inch apart, and at about the middle of its course. The peritoneum overlying the vessel in this particular spot had apparently been stripped away (operative exposure). Between the two ligatures there was a small longitudinal rent involving all coats of the artery.

The rest of the autopsy findings were essentially negative except for an acute bilateral broncho-pneumonia.

Microseopal sections were made of the vessel, above, through, and below the tear. The sections taken above and below the tear show a normal vessel wall. The section through the tear shows a complete rupture of the vessel wall without any apparent inflammatory process in any of the coats of the vessel.

CASE II.—Hospital No. 238594. The patient was thirty-four years old and was admitted to the hospital on the second day of an attack of acute appendicitis. There had been a typical onset with diffuse abdominal pain, radiating to the right lower quadrant with nausea, but without vomiting.

The physical examination demonstrated rigidity with direct and rebound tenderness in the right lower quadrant. No mass was palpable. The rectal examination was negative. The remainder of the physical examination gave no positive information of any kind.

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Operation was performed immediately upon admission by Doctors Colp and Selig. The appendix was found to be bound around with inflamed omentum and was surrounded by an abscess. A fecolith lay free in the abscess cavity. The appendix was gangrenous and perforated. The inflamed omentum was resected and the appendix was removed in the usual manner. The abdominal wall was closed in layers, except for an opening through which a tube emerged from the abscess cavity.

Thirteen days after the operation the sutures were removed and the tube was shortened. On the sixteenth day there was a sudden profuse hemorrhage from the wound. The tube was removed and the wound was packed with gauze. Inspection of the wound a few hours later showed no active bleeding. Nevertheless the wound was repacked. The next morning, on removal of the packings, the hemorrhage was repeated. The patient was immediately brought to the operating room and the original incision was extended. (Operation by Doctor Wilensky.) A short section of the deep epigastric artery lay exposed in the wound margin and blood was seen to spurt from a small opening in the exposed portion of the vessel wall. About three centimetres of the injured vessel were resected between ligatures and the wound repacked with gauze. There was an uneventful recovery.



FIG. 3.

We are indebted to Dr. F. S. Mandlebaum, Pathologist to the Hospital, for the following notes of the histological examination of the excised portion of deep epigastric artery from the preceding case:

FIGURE 1.—Section of a medium-sized artery together with some perivascular tissue. The intima presents a normal appearance for about one-half of the circumference of the vessel. The remaining half of the intima is greatly thickened and protrudes into the lumen, converting the latter into a crescentic channel. This thickening of the intima is due to the presence in it of connective tissue, round cells, and fibroblasts. The endothelium is intact. The internal elastic lamina presents a normal appearance except for some thickening and loss of its wavy outline in the region corresponding to the thickening of the intima. The media is normal the adventitia shows some slight round cell infiltration and increased vascularity. The perivascular tissue consists of granulation tissue containing many capillaries, round cells, histiocytes, and a few giant cells.

FIGURE 2.—The Weigert elastica stain shows the internal lamina as described in Fig. 1. The above sections were made at a point removed from the site of rupture of the artery.

FIGURE 4.—A cross-section of the artery showing but very little normal structure. One-half of the circumference of the vessel is greatly thickened and bulges outward. Here the normal structure is entirely missing and is replaced by blood, fibrin, and numerous polymorphonuclear leucocytes. The remainder of the vessel is formed by thinned-out adventitia. The intima and media have been ruptured with a resulting suppurating aneurismal sac. Adjoining this area is thickened fibrous intima with the corresponding internal elastic lamina sharply ending at the point of the rupture of the vessel. The media presents a somewhat hyaline appearance. The surrounding fat and connective tissue shows acute and chronic inflammation with marked vascularity and many phagocytic cells. Accompanying the artery is a vein (not seen in photograph) the lumen of which is practically completely occluded. The elastic stain of this section (*Figure 5*) shows the abrupt disappearance of the internal elastic membrane at the site of the aneurismal formation and the thinned out adventitial tissue forming the wall of the latter.



FIG. 4.

the cells of the thickened intima are apparently in good condition and all of them appear distinctly viable. As we come closer to the actual site of rupture we see that the cells in the thickened portion are apparently undergoing necrosis. At this point we also note the beginning of the cleft in the vessel wall. (*Figure 3.*) This cleft extends through the intima and media, almost to the adventitia. Figures 4 and 5 are further stages in the process, showing the formation, practically speaking, of an aneurismal sac with subsequent rupture.*

Discussion.—The various factors involved in this accident are (1) trauma. (2) pressure by tube, or other drainage apparatus, and (3) infection.

1. *Trauma.*—It is difficult to make a decision as to the rôle the factor of trauma plays. As pointed out previously in this communication, the claim has been put forth that if the artery is covered by intact healthy peritoneum, no hemorrhage will occur from the underlying vessel. There is no experimental or other evidence available in the literature which can help in making

* We are indebted to Mr. Oneil, of the College of Physicians and Surgeons, New York, for the photomicrographs.

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a decision as to this factor. There have been numerous opportunities of examining, post-mortem, drainage tracts reaching into the peritoneal cavity. In no one of these had there been any evidence of any agglutination or other abnormal relation between the overlying peritoneum and the underlying vessel. In the first of the two cases reported in this communication, the drainage tube had been pulled out on two occasions after each of which the tubes were replaced with a certain amount of difficulty. In this instance the post-mortem specimen showed that the vessel had become agglutinated to the parietal peritoneum in the immediate region of the drainage tract, and that the rent had occurred in the vessel in the centre of the agglutinated area. It is questionable whether the agglutination could, or would have occurred, spontaneously, and it does not seem reasonable to assume that it had something to do with the preceding trauma—pulling out and replacement of the tubes. The injury had probably resulted in a tearing of the peritoneum; subsequently exudate had formed in and around the rent, which had glued the vessel to its overlying peritoneum. Such pathology would predispose to the secondary bleeding.



FIG. 5.

In our second case, apparently there was no gross trauma, either operative or accidental. Still in cleaning the wound during the daily dressings, and frequently this includes the temporary removal and replacement of the tube or tubes, there is abundant opportunity for microscopical, or even larger traumata in the inflamed scar tissue which lines the drainage tract.

2. *Pressure of Drainage Tubes.*—It is necessary to distinguish between the cases in which infection is absent, and those in which it is present. The pressure of the drainage tube causes pressure atrophy of the tissues in close apposition to it, so that the tissues forming the drainage tract accommodate themselves to the size, direction, and other physical characteristics of the tube.

We have never seen a vessel become exposed in the margin of an operative wound irrespective of the position this vessel occupies in the body—abdominal

cavity, extremity, etc.—when the wound conditions are those of an aseptic healing. If a vessel lie in close relation with a surgically aseptic drainage tract, some change necessarily becomes transmitted to it, but the degree of this change must necessarily vary in direct proportion with the thickness and character of the intervening tissues. The experimental work done upon dogs recently by Shoenbauer and Gold shows that the mere contact of rubber tubes with large pulsating vessels, such as the aorta, in uninfected wounds, causes, instead of atrophy or erosion, an actual protective thickening of the vessel wall at the point of contact. Microscopical sections of the vessels taken a few weeks or less after insertion of the tubes, showed at the point of pressure, proliferation of the intima and thickening of the media and adventitia.

When, however, the conditions of the experimental wound were other than that of aseptic healing, different results were obtained by Shoenbauer and Gold. When the elements of trauma or of infection or of both were added, perforation of the vessel could be produced.

Both of these pictures are illustrated in the sections of the vessel described in this communication. There is the initial thickening which, in accordance with the work of Shoenbauer and Gold, can be assumed to have a protective function. Then there is the subsequent infection with all the physical changes leading to the formation of an aneurism and the final rupture and hemorrhage. In an infected environment instances are numerous in which vessels become exposed in the margin of the wound; secondary bleeding is then a common phenomenon. Here, the thickness of the tissue between the surface of the wound and the subjacent blood-vessel is an important factor, and when the intervening tissue is of considerable bulk, the vessel usually remains covered and hemorrhage does not occur. The paucity of intervening tissue is especially to be noted in certain classes of operative wounds, notably in rectus muscle incisions in the abdominal wall and in incisions made for deep-seated infections of the forearm on its anterior aspect. In rectus muscle incisions this is aided by carelessness in planning the incision; if the incision in the peritoneum is made too close to the centre of the muscle, the deep epigastric vessels lie in much closer contact with the line of incision and with any introduced drain than if the peritoneal incision is made close to the outer boundary of the muscle.

The microscopical pictures of the second case described in this communication show that the mechanism causing the bleeding is that of a ruptured traumatic aneurism. In another instance—a case of infection of the forearm—this was proven; a definite aneurism actually formed and became visible; hemorrhage was prevented by ligation of the vessel above and below the aneurism with excision of the latter. I give the clinical and laboratory notes of the case.

Hospital No. 194280. On August 15, 1919 a patient was admitted to the hospital with a severe infection of the hand and forearm. Sometime previously he had suffered a laceration of the palmar surface of the hand; the latter had been sutured; later it became infected and as a result of this, a lymphangitis appeared and spread upwards in the forearm and arm.

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On August 18, 1919, a number of incisions were made into the anterior surface of the forearm by Doctor Moschcowitz. It was established that there was a purulent infection of the tendon sheaths in addition to the lymphangitis. The resulting wound was treated by the Carrel-Dakin method.

During the subsequent dressings, the Carrel tubes were changed a number of times. The wound had become partially necrotic and there was a considerable discharge of pus. At the beginning of September a small aneurismal sac was noted in the course of the radial artery and in order to prevent any secondary hemorrhage, the latter was excised between ligatures applied below and above it on the vessel. There was an uneventful recovery.

The specimen removed showed a definite aneurismal sac in the course of the radial artery. The sac wall was extremely thin and apparently on the point of rupture.

SUMMARY

The evidence appears strong that infection is the most important single factor, if it be not the only factor, causing secondary hemorrhage in operative and other wounds. The studies herewith reported show that the presence of the drainage apparatus causes an apparently protective thickening of the wall of the vessel with which the drainage material is in close contact; that this thickening is due to a proliferation of connective-tissue cells in the intima; that the infective process with resultant cell necrosis begins in the intima and spreads to the media; that a rupture occurs in the intima and media with the formation of an aneurismal sac; and that the bleeding follows as a result of the rupture of the aneurism. It seems, then, that in cases of secondary hemorrhage such as have been described, the important causative factors include an initial trauma of some kind, plus pressure of the tube or other drainage apparatus in an infected environment.

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FRACTURE OF THE LARYNX

By THOS. F. MULLEN, M.D.

OF POCATELLO, IDAHO

ALTHOUGH a search of the literature upon the subject does not reveal a very large number of reported cases of fracture of the cartilages of the larynx, Hofman,¹ having been able to collect only 124 cases, it seems that they are not of infrequent occurrence. Th. Patenka² convinced himself that they were met with quite frequently. That these fractures are uncommon enough to be of interest is probably due to the elasticity of the structures, the protection afforded by the lower jaw and the mobility of the larynx itself. There are, no doubt, cases of fissure or simple fracture of a single cartilage which are undiagnosed and are treated as simple contusions of the neck. Lane³ reported nine cases of fracture of the larynx found in dissecting room subjects and stated, that after examining them, he came to the conclusion that the symptoms they produce are not always as severe or as characteristic as they are described to be, so that the injury itself escapes observation during the patient's lifetime.

Morgagni first described the condition, and several cases were incompletely reported by Malgaigne. The first accurate description was given by Gurlt⁴ who reported sixty-eight cases, and G. Fisher,⁵ in an interesting account, collected all of the cases recorded up to the year 1881. Harris⁶ in 1895 stated that up to the year 1866 very little was known concerning these injuries. The accounts of Hunt,⁷ Henocque,⁸ and Durham⁹ added materially to the statistics upon the subject.

The Mechanism and Pathological Anatomy.—The larynx is fractured more frequently in adult life, probably on account of the greater exposure to injury at this time and to the increased calcification of the cartilages. Cases do occur, however, even in early childhood. Hume¹⁰ reports a fracture of the larynx in a child six years old, in which death occurred before anything could be done.

The time of calcification and later ossification of the cartilages is very variable, sometimes it is noted in early adult life and again it may not be present even in extreme old age. Dean¹¹ speaks of unusual calcification occurring in young persons and Shattock¹² mentions extensive ossification in the larynx of a dissecting room subject of middle age. On the other hand, Hunt⁷ has noted a case of a man of 103 in whom the cartilage was very little ossified. The cuneiform cartilages, the epiglottis and the apices of the arytenoids being composed of yellow elastic cartilage, show little tendency to calcification, on the other hand the cricoid, thyroid and the greater part of the arytenoids, which consist of hyaline cartilage, become more or less ossified as age advances. Ossification commences about the twenty-fifth year

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in the thyroid cartilage, somewhat later in the cricoid and arytenoids and by the sixty-fifth year these cartilages may be completely converted into bone.

Fracture may occur in any or all of the cartilages, but as a rule the thyroid is the one involved. Fisher⁵ reports the following incidence in seventy-five cases:

Thyroid	29
Cricoid	11
Thyroid and cricoid	9
Hyoid and thyroid	3
Hyoid, thyroid and cricoid	2
Hyoid, thyroid, cricoid and trachea	1
Hyoid, thyroid and trachea	3
Trachea and thyroid	1
Cricoid and trachea	2
All parts of the larynx	14

The thyroid may fracture on account of its anterior angle being spread or compressed, the latter is, perhaps more frequent as blows are more often delivered from the side. Davis¹³ stated that the fracture may be oblique, vertical or irregular, or involve only the cornua. The external perichondrium may rupture and the mucous membrane be torn or completely detached. Both wings of the thyroid may be flattened so that the internal outline of the larynx is distorted or obliterated.

Fractures of the cricoid and multiple fractures are usually accompanied by severe injury to the adjacent structures, thus determining the fatal issue so frequently seen in these types of break. Lockwood¹⁴ reports a case in which death was due to a coincident crush of the vagus. The large vessels of the neck and the nerves may be hopelessly destroyed. If the cricoid breaks only in one place, it is usually behind; if in more than one place the breaks are scattered.

Either one or both arytenoids may be separated from their attachments to the cricoid, permitting relaxation of the vocal cords. In one of Hunt's⁷ cases the right arytenoid was detached and in the case herewith reported both arytenoids were completely separated and their bases turned forward. Morton¹⁵ said that combined fractures of the cricoid and the thyroid are rare and that fractures involving both the cartilages of the larynx and the hyoid bone are almost unknown. Interesting examples of this combined injury have been noted by E. Jaumaire¹⁶ and J. E. Kelly.¹⁷ Both direct and indirect force may act in producing these injuries. Gurlt⁴ described two factors in their production by direct force.

First.—Compression from the side, as in strangulation, causing oblique fractures of the thyroid and double fractures of the cricoid.

Second.—Crushing of the larynx from front to back, causing oblique or vertical fractures.

Stoessel,¹⁸ in an exhaustive study, describes the mechanism in the production of vertical fractures. The manner in which direct force may be exhibited is manifold; blows, kicks, flying objects and falls. It is interesting

to note how many of the reported cases were due to stumbling in the dark and striking the throat on the back of a chair.

Sokolowski¹⁰ describes the interesting case of a peasant girl who had her apron caught in a reaping machine. According to the local custom she wore it on her back, with the strings tied in a knot in front. The tightening of the strings caused an oblique fracture of both wings of the thyroid. J. B. Berry²⁰ and T. B. Eastman²¹ have noted cases caused by a piece of wood thrown from a circular saw. E. J. Moure²² has told of a case due to the snap of a whip lash. Several interesting reports on the relation of these injuries to industrial accidents have been made, Gland Fils,²³ Dewatripont, L.,²⁴ Dupond, G.,²⁵ Lockwood, H.,¹⁴ having made studies in this regard. Several cases have been reported as caused by strangling, one by Kemper, G. W. H.²⁷ and one by Aubry, P.²⁸ In France, where garrotting was a common means of assassination, cases due to this form of direct violence are noted, and some very interesting studies on the medico-legal aspects of these cases have been made. Von Hofman,²⁹ De Aigre,³⁰ Couvin,³¹ and in this country by Vinnedge, W. W.²²

That indirect force can also cause a fracture of these structures is evidenced by the report of cases. It usually occurs in persons in whom there has been previous trauma to the larynx with subsequent necrosis or inflammatory change in the cartilages. A. W. DeRoaldes,³³ treated a case in a male, aged thirty-three years, who having accidentally lodged an olive in his throat, attempted to produce vomiting and suddenly felt a cracking in his neck followed by local pain and disability, caused by a fracture of the left cornua of the thyroid cartilage. In one of Harris' cases the accident occurred while the patient was playing a musical horn. There was a crackling sound, pain in the right side of the neck, swelling, loss of voice and dysphagia, due to a fracture of the right cornua of the thyroid.

It has been stated by some writers that fractures of the larynx never occur from hanging owing to the position taken by the noose. Caspar, quoted by Ashhurst,³⁴ stated that it did not occur. However, a case is noted by Porter³⁵ of a fracture of the cricoid by hanging, and in the official report of the autopsy on the body of the assassin Guiteau, mention is made of wide separation of the hyoid bone and the thyroid cartilage, with rupture of the thyro-hyoid membrane, although nothing is said of a fracture. Morgagni wrote, "I have seen with Val Salva, a hanged man, who had the sterno-thyroidea and the hyothyroidea muscles torn, so that only a membranous substance remained in their place about the annular cartilage, and this very cartilage was broken asunder."

Associated with the fracture itself, as has been stated, the mucosa may be torn, permitting the air to gain access to the cellular tissues of the neck, with great swelling and emphysema. The cartilages may be fragmented and torn loose or displaced and there may be bleeding with the formation of submucous hæmatomata or flooding of the bronchi. There is a possibility of sub-hyoid and peri-pharyngeal abscess, necrosis of the cartilages and other inflammatory reaction in those cases due to direct force. In the compound fractures, and

indeed even in the slightest injuries, there is ever present the danger of infection of the respiratory tract with purulent bronchitis or broncho-pneumonia. Mediastinitis or cellulitis of the neck and submental regions may occur.

Stenosis of the larynx, adhesions of the vocal cords, and cicatricial narrowing of the glottis, due to the injury itself or to faulty treatment, may give rise to permanent alteration in the anatomy and physiology of the parts.

Symptoms and Signs.—St. Clair Thomson,³⁶ describes the usual symptoms as “local pain, tenderness and swelling, with more or less interference with phonation, mastication and deglutition.” Hæmoptysis may occur and was regarded by Hunt as a particularly unfavorable sign as indicating that laceration of the mucous membrane had taken place. Pain is elicited by movement, swallowing and by handling the neck. Dyspnoea may be marked and of extreme urgency. Asphyxia with its attendant signs may appear early or occur later, even in those who appear quite convalescent, being in these cases probably produced by the displacement of a piece of cartilage or by sudden emphysema. Ecchymosis of the neck, with marked cyanosis of the face and upper part of the thorax may be seen.

Manipulation of the larynx may disclose a fissure, show displacement, mobility of the fragments or crepitus, which should not be confounded with that produced by the normal larynx gliding over the anterior surface of the cervical vertebræ.

Laryngoscopic examination may reveal a pale œdema, or redness and swelling, congestion or hemorrhage, and show to what extent respiration is interfered with. The false bands may be found to be reddened and swollen to a prodigious degree, causing stenosis of the glottis. The upper portion of the thyroid cartilage may be seen to be flattened and pushed into the larynx, or completely detached portions of cartilage may be seen. Bleeding points, tags of membrane or foreign bodies may be discovered.

Emphysema of the neck is a very serious symptom that is quite likely to supervene, the air gaining entrance through a tear in the mucosa and expanding the cellular tissues. It may extend to the tissues of the face, thorax, back, arms and abdomen, as mentioned in a case of Hawthorne.³⁷ An instance has been remarked by Middleton,³⁸ with extensive emphysema, wherein the pericardial fat as well as that of the mediastinum was loaded with air, so that it had a swollen, sponge-like appearance. In Humes' case the emphysema was so great that there was compression of both lungs. Tilleaux³⁹ tells of a curious case of swelling of the soft palate following a fracture of the larynx. Crepitation appears early and may rapidly extend. The symptoms, one or all, with varying degrees of disability, may appear at once, or may be delayed for some time, even until after the patient has regarded the injury cured. Morgenthau⁴⁰ mentions the case of a man who presented himself three weeks after the infliction of an injury, seeking treatment for hoarseness. Barling and Wilson⁴⁰ mention that of a man who came to them sixteen days after being injured, complaining of pain, hoarseness and dysphagia, and others have noted instances in which the symptoms did not become of sufficient

gravity to cause the patient to seek surgical aid for periods varying from six to fourteen days. On the other hand, it is not uncommon for symptoms of the utmost urgency to make their appearance with almost fulminating rapidity and progress to a fatal issue before anything can be done.

Prognosis.—Agnew stated that every case was one of the most serious nature, and cautioned great reserve in venturing an opinion as to the final outcome. That these injuries have been attended by a high mortality in the past is shown in the figures given by Durham and quoted in Holmes System of Surgery; death occurred in 88 per cent.; Albert's series showed 80 per cent. mortality, Fisher's 78 per cent.; and Gurlt's 70 per cent. In thirty cases Harris states that in five where the cricoid was fractured the mortality was 20 per cent., where the thyroid was fractured, 20 cases, death occurred in 20 per cent. and in five cases of multiple fracture 60 per cent. died. These data of Harris throw some doubt on the statement that fractures of the cricoid are invariably fatal. Roe.⁴² In one of Lane's cases before mentioned, there was a healed fracture of the thyroid and cricoid, which had nothing to do with the death of the person. Mansucci, B.,⁴³ and Major, F.,⁴⁴ have both reported cases of fracture of the cricoid in which recovery occurred. Death is, as a rule, due to interference with respiration, and it may occur within a few moments, Chauvel,⁴⁴ Story, G. B.,⁴⁶ or may be delayed for some time, Knaggs.⁴⁷ When occurring at the latter period, death is usually due to infection or pneumonia. In the event of recovery it is quite possible that the voice will be permanently altered, Packard, J. H.,⁴⁸ and hoarseness may persist for a very long period. It may be necessary to permanently wear a tracheotomy tube, owing to stenosis of the larynx, adhesions of the vocal cords, or cicatricial contraction. Shields.⁴⁹ These sequelæ can, however, be minimized by a proper attention to detail in the after-care. Practically all cases of laryngeal stenosis can be cured by laryngostomy.

Treatment.—Undoubtedly in those cases where there is no deformity or depression of the fragments, no hemorrhage, emphysema, swelling or dyspnoea, where laryngoscopy reveals no encroachment on the lumen of the larynx, expectant treatment is attended by satisfactory results in a certain number of instances. Under these circumstances the patient should be placed in a quiet room, in an atmosphere kept warm and moist. Complete silence should be enjoined, all efforts to use the voice being absolutely forbidden. Communication with the nurse or attendants may be had by means of a pad and pencil. Abstinence from food for a few days, nourishment and fluid being supplied by rectum. Under all circumstances very careful surveillance should be maintained. The attending surgeon should hold himself in readiness to deal promptly and decisively with any untoward development. Manby⁵⁰ records the case of a patient treated expectantly in whom there suddenly developed, on the third day, very urgent dyspnoea. Tracheotomy was resorted to and after a few days of storm the patient recovered. In the same vein, LeJars⁵¹ quotes Atlee,⁵² who has told of a case in a child, who striking his neck against an iron boot scraper, had a transitory attack of suffocation. Some

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time after while sitting quietly by his mother, breathing normally, without any apparent signs of serious injury, he suddenly threw himself violently backwards. An enormous swelling appeared in the neck, spreading rapidly over the head, back and upper extremities, death occurring in a few moments. Hektoen⁵³ tells of a case expectantly treated in whom sudden death occurred from œdema of the glottis. These instances impress one with the need of constant watchfulness. In the more urgent cases where the patient is seen soon after the accident, and is shocked, perhaps unconscious, with the face swollen and purple, the skin cold and the pulse feeble, the neck distended with a tympanitic, crepitating swelling which extends from the jaw down over the chest and may be visibly enlarging, immediate tracheotomy is demanded. (Marcigny.⁴⁴ Eastman.²¹) The immediate indication is to free the air passage and it should be done at once and with any possible instrument as best it can. Tracheotomy under these circumstances may be difficult, and when performed on a neck swollen and distended with blood and air, with landmarks obliterated and on a struggling patient, it is not the simple procedure that it is under circumstances less urgent. LeJars⁵¹ graphically described the operation under these conditions. Chevalier Jackson⁵⁵ has recently written on the operation of tracheotomy and advises in all circumstances a low tracheotomy in order to prevent laryngeal stenosis. In the event that the trachea has to be opened high, he warns against wearing a tube in the high position, but states that a second more deliberate opening should be made lower down for the insertion of the tracheotomy tube. He states that the operation of tracheotomy is much simplified by splitting open the entire front of the neck exactly in the midline, so as to obtain a large wound in which to feel for the trachea.⁵⁹ After the trachea is opened and a passage assured, it may be advisable to aspirate the tracheo-bronchial tree in as far as is possible by introducing a rubber catheter through the cannula and drawing out the blood and mucus with the aid of a syringe or bulb. Letarget⁵⁶ tells of a case so treated. After tracheotomy the patient appeared to be beyond help. Aspiration was performed by attaching a rubber bulb to a catheter and a vacuum maintained. The tube was slowly withdrawn and a clot six inches long was found attached to the end of it. This was repeated five or six times, each time with the same result. Respiration began, cyanosis disappeared, and the man went on to recovery. A slender copper tube attached to a mechanical aspirator such as is used in nose and throat operations, is more efficient; and a small bronchoscope and forceps may be required for firm clots. (Jackson.⁶⁰) Artificial respiration may have to be resorted to after the passages are clear and the condition should not be regarded as hopeless until this has been continued for some time without success. Bronchoscopic oxygen insufflation is invaluable after bronchoscopic clearing of the airway. (Jackson.^{59, 60}) General anæsthesia should be avoided, but in the event that it is necessary, the intratracheal method will insure the patient's safety and greatly facilitate the work of repairing the injured structures. After the air passages are open and the respiration established, one should undertake to repair the damaged

tissues. A laryngo fissure may be performed and the traumatized tissues deliberately inspected and repaired. Displaced pieces of cartilage with intact blood supply may be replaced, blood clots removed, bleeding points ligated and lacerated mucous membrane repaired by suture. The suture should carefully approximate the torn margins without strangulation so as to avoid as much as possible death of the tissue and subsequent scar formation. Displaced cartilage may be fixed in position by suture as in a case reported by Briddon,⁵⁷ though as a rule the thyroid cartilage holds sutures badly. (Chevalier Jackson.^{59, 60}) The arytenoids may be replaced and secured by suture. If oozing of blood persists, the cavity of the larynx may be packed with gauze and the air current assured through the tracheotomy opening. The external wound should be carefully sutured in the anatomical planes and proper drainage established. The tracheotomy wound should not be sutured but lightly packed with gauze. The dressings must be changed hourly and the utmost care taken to prevent the accumulation of tissue fluids and saprophytic organisms in the highly infected secretions from this type of wound. Downing and Boularin⁵⁸ have written upon the indications for suture of the larynx and trachea. Jackson⁵⁹ states: "The tracheotomy tube must be of the proper size and shape and material, and without fenestrations. Rubber and aluminum should not be used. The inner cannula should be cleansed hourly or oftener. The outer cannula should be removed at least once a day, cleansed, smoothed, polished, sterilized and fitted with clean tapes. For this daily toilet duplicate cannulae should be provided." The cannula should be removed at the earliest possible moment, it should be partially corked (Jackson,^{59, 60}) for a gradually increasing period of time on several days before it is completely removed, since as it is much easier to breathe through the neck the patient may resist all efforts at removal of the cannula. After operation the patient should be kept in a warm, moist room, silence enjoined and small doses of morphia and atropine administered to combat restlessness and limit as much as possible the amount of secretion. After the tube is removed and the wound healed, further intervention may be needed for the cure of strictures of the larynx, adhesions of the vocal cords and narrowing below the glottis. "If cicatricial stenosis is impending, it is better to do a laryngostomy at once. (Jackson.⁵⁹) This procedure consists of splitting the thyroid cartilage in the midline; and the wearing of, first a pack, then a rubber tube in the larynx supported on a laryngostomy cannula, instead of the ordinary tracheal cannula, until the interior of the larynx is epidermatized with epidermal epithelium and the larynx is converted into an open trough. This requires many months of treatment during which the apparatus must be changed daily, and the size of the rubber tubing must be increased from time to time. As shown by Gabriel Tucker, the best way to increase size smoothly and evenly is to slip a rubber glove finger over the tubing. The open trough is closed by a plastic operation after a six months' test period has demonstrated that the laryngeal stenosis will not recur." (Jackson.^{59, 60, 61})

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CASE I.—A male laborer, age twenty-three, had his throat caught between an elevator gate and an elevator sustaining a compound fracture of the larynx. Was badly shocked when first seen and was unable to speak. Immediately below the mandible there was a lacerated wound extending from the angle of the jaw on right, around to the angle on left, the soft tissues were stripped from the mandible exposing the bone for its full length. Large vessels were not damaged. Tissues of the neck and face were emphysematous, emphysema visibly enlarging. Respirations labored and difficult.

Operation: August 10, 1915. A high tracheotomy was performed and the larynx opened through a vertical incision. The thyroid cartilage was comminuted. The arytenoids were broken off from their attachments at the base and the vocal cords relaxed. There was free bleeding from the lacerated mucosa. The fragments of the thyroid cartilage were sutured with fine catgut approximating the edges, but not overlapping. The arytenoids were fixed in place by means of three sutures of catgut. Then a low tracheotomy was done and the wound of the high tracheotomy and in larynx closed by suture. All bleeding carefully controlled by ligature and the large wound in the neck closed by suture in layers. The wound was drained with rubber strips extending to its depth, and the skin was then partially closed. Intratracheal anæsthesia—ether.

August 18, 1915. Condition good. Wound draining freely. Tube changed hourly, cleansed and replaced.

September 5, 1915. Tube removed and allowed to remain out. Very little air escaped through wound. Tube had been closed for varying intervals on several previous days. On two occasions during following few days had severe attack of dyspnœa and it seemed imperative to again replace the tracheotomy tube. Larynx cleansed with sodi Bicarb. solution and 5 per cent. cocaine, after which he was much easier and had no more difficulty in breathing.

September 25, 1915. Discharged, good condition, no dyspnœa. Voice hoarse but understood at distance of several feet.

Two years later.—No difficulty in breathing, but voice hoarse and husky.

CASE II.—Adult male, thirty years of age, struck in throat by piece of wood thrown from a saw. Shocked, dyspnœa and cyanosis, crepitating swelling from mid-sternum up to eyes and extending back over neck and occiput. Pulse 110, small and thready. Skin not broken.

October 12, 1917. Immediate operation. Local anæsthesia, 1 per cent. novocain, infiltration. Low tracheotomy done and tube inserted. Cyanosis cleared and patient brightened. The right thyroid cartilage was fractured obliquely and comminuted. The crepitation was marked when larynx was grasped between fingers. Laryngeal fissure was done and interior of larynx inspected. A small piece of cartilage had been forced through mucosa. This was removed and rent sutured with fine chromic catgut. The fragments of cartilage were held in position and secured by several sutures of fine chromic catgut, and wound in neck closed in layers without drainage.

Tracheotomy tube removed in twelve days. Emphysema subsided. Tube replaced temporarily twice the following day and permanently removed on the fourteenth day. Wound closed by first intention. No complications. Voice husky but improving when seen three months after discharge.

CASE III.—In July, 1918, there was brought into my service at the American Ambulance in Paris, a soldier who had been struck in the neck by a spent piece of shell. Pain had been severe but subsided and when seen by me twenty hours after injury his only symptoms were moderate dyspnœa and marked swelling of the front of the neck. He was watched for sudden symptoms and taken to operating room a few hours after admission. While waiting for anæsthesia to begin he expressed a desire to sit up. After a few moments, feeling better, he assumed recumbent position. After only one or two whiffs of ether he suddenly became cyanosed, swelling of neck increased and death occurred in a few moments in spite of immediate tracheotomy and continued efforts at resuscitation.

Autopsy revealed a fracture of the thyroid cartilage, compound into larynx, with an area of infection about the wound, and great infiltration of the cellular tissues of the neck.

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TRAUMATIC FAT NECROSIS OF THE FEMALE BREAST AND ITS DIFFERENTIATION FROM CARCINOMA*

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A THIRD REPORT FROM THE MEMORIAL HOSPITAL

IN May, 1920,⁷ we presented before the American Surgical Association our first report upon Traumatic Fat Necrosis of the Female Breast. The object of this communication was to establish the condition as a new clinical entity and to point out the striking similarity of this hitherto unrecognized tumor to carcinoma of the breast. In May, 1921,⁸ we had collected three additional cases from the Breast Clinic of the Memorial Hospital, and a further report was made. Since that time four additional cases have appeared in the Clinic, and Bloodgood, of Baltimore, Kilgore, of San Francisco, and Hyman and Berg, of New York, have kindly permitted us to include unpublished cases of their own in the present series. Meanwhile, Cohen and Parsons in America and Stulz and Fontaine in France have each published an additional case. The present paper represents an effort to place on record all authentic cases, with some additional considerations concerning the clinical and pathological features of this disease.

Nature of the Process.—Fat necrosis is a disintegration of fat cells with the associated tissue reactions of new connective tissue formation and the production of foreign body giant cells. For many years, fat necrosis has been most frequently encountered as the acute necrosis of fat in the omentum and mesentery secondary to acute pancreatitis. These changes in fat tissue have been produced by the pancreatic fat-splitting ferment, and the lesions may be easily reproduced experimentally as Opie⁹ Wells,¹³ and Langerhans⁵ have shown.

Similarly, we have all recognized that fat necrosis may appear in subcutaneous tissue following trauma. In new-born babies the trauma of a difficult instrumental delivery sometimes produces a tumor having the identical microscopical picture of fat necrosis of the breast. Occasionally surgeons encounter fat necrosis of subcutaneous tissue secondary to a hypodermic injection, or some other form of trauma, and a similar appearance may be found at times along an old healed suture line. Farr² reported several such cases and further produced these lesions experimentally in fat pigs.

Although the gross and microscopic picture of traumatic fat necrosis occurring in subcutaneous tissue in other parts of the body closely resembles that occurring in and about the breast, these lesions are far less important clinically than the particular condition we are describing. The clinical prob-

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lem of traumatic fat necrosis of the breast is an important one, for this condition must be considered in properly differentiating tumors of the mammary gland. The process often seems progressive for a time, resembling a true tumor growth, and the close simulation to carcinoma of the breast makes it additionally important from the clinical standpoint. In the breast the great bulk of fatty tissue permits after trauma the formation of a tumor of some size, the largest mass encountered in the present series being 7 cm. in diameter.

Stulz and Fontaine¹² in September, 1923, in reporting a personal case, also included in their paper, cases reported by Lanz in 1882, Berner quoted by Heyde in 1911, and Kuttner in 1913.

In the Lanz and Kuttner cases the masses of fat necrosis were situated in the subcutaneous tissue overlying the breast, and Case IX of our own series, as well as Case XIII, also showed a similar involvement of subcutaneous tissue. The clinical appearance of these subcutaneous tumors overlying the breast is practically identical with the signs elicited when the fat necrosis is more deeply placed within the breast tissue. The cases of traumatic fat necrosis occurring in and about the breast may therefore be classified in one of two groups, namely:

Group A.—Tumors actually occurring within the breast.

Group B.—Tumors occurring in subcutaneous tissue overlying the breast.

In Group A, from our personal series and the literature, there are sixteen cases, namely:

Cases 1 to 8 (personal series)	8
Cases 9 to 12 (personal series)	3
Case 14 (personal series)	1
Case of Berner, quoted by Heyde	1
Case of Cohen	1
Case of Stulz and Fontaine	1
	—
Total of Group A cases	15

In Group B, there are five cases, namely:

Cases 9 and 13 (personal series)	2
Case of Lanz	1
Case of Kuttner	1
Case of Parsons ¹¹	1
	—
Total of Group B cases	5

The French authors mentioned object to our term "traumatic fat necrosis," proposing as a substitute "granulome lipophagique traumatique." We believe this term is a poor one, for the word "granuloma" is associated with the idea of infection, which apparently has no part in the production of this lesion. Upon the other hand, traumatic fat necrosis of the female breast is a disintegration of fat cells caused by trauma, with resultant necrosis and associated connective tissue reaction and the production of foreign body giant cells. Therefore, the term "traumatic fat necrosis of the breast" appears to be the proper one and more truly descriptive of the disease.

The difficulty in differentiating this tumor grossly and microscopically has been described below by Dr. James Ewing.

DIFFICULTIES OF PATHOLOGICAL DIAGNOSIS IN THE DIFFERENTIATION OF TRAUMATIC FAT NECROSIS OF THE BREAST FROM CARCINOMA

"The gross appearance of the lesions in fat necrosis resemble in many respects that of carcinoma, and in some cases it is difficult to distinguish between the two conditions. In both there is often the same firm induration which is readily explicable because the induration is caused by growth of new connective tissue which is progressively cicatrized.

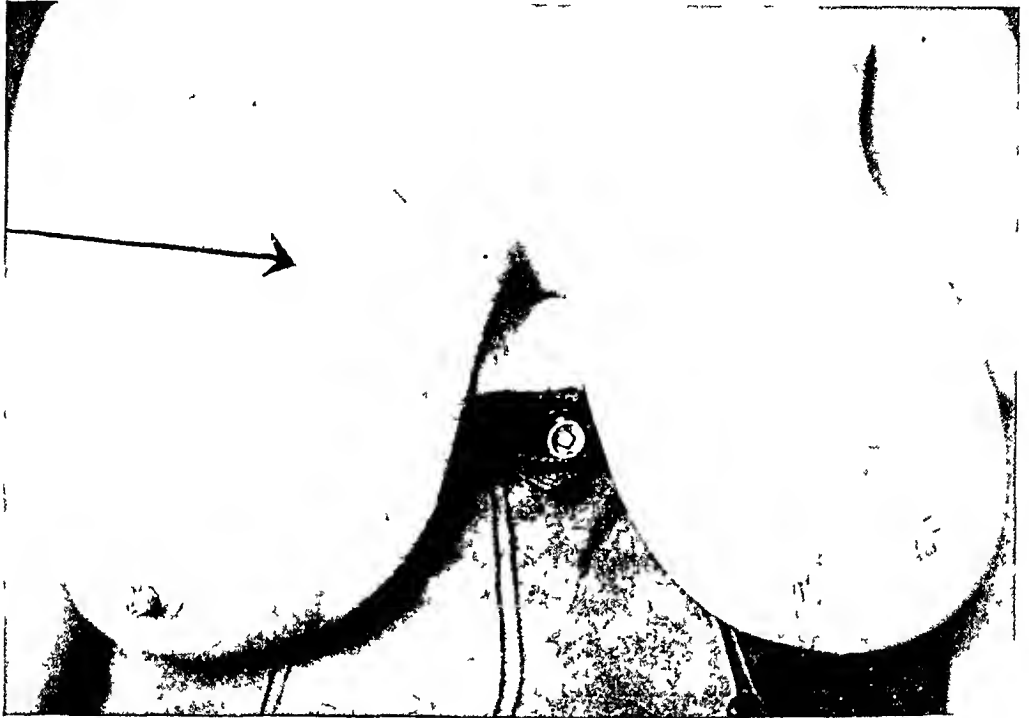


FIG. 1.—Case III. Breast lipomatosis Breast reaches to umbilicus. Patient's weight 191 pounds.

From a consideration of microscopic structure the induration should be greater in infiltrating carcinoma. The outline of the gross lesion in carcinoma is generally much sharper than in fat necrosis, which may fade off gradually into surrounding areas. Chalky points and streaks of fatty epithelium lying in firm translucent connective tissue are characteristic of infiltrating carcinoma. The same whitish points are present in necrotic or inflamed fat tissue, but they are generally much broader and more irregular. Occasionally one finds a whole fat lobule as large as a bean, chalky and opaque from the proliferation of fat cells, in inflamed fat tissue. Carcinomatous nodules in the breast are nearly always single, whereas traumatized fat is often very irregularly distributed and cicatrization appears in multiple points. In fat necrosis the new connective tissue is much more translucent than in carcinoma and often it is of a faint reddish color from the presence of fine capillaries, which are absent in carcinoma. Later, cicatrization obliterates these capillaries and the connective tissue of fat necrosis becomes as dense and opaque as in carcinoma.

"In a recent case of supposed fat necrosis, a firm resistant area 2 cm. wide was encountered in a lipoma of the breast. The opacity and chalky streaks of carcinoma were missing, but a correct diagnosis of carcinoma was made on the very firm induration, rather sharp borders, and on transmitted light, the marked opacity of the lesion. In

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another very puzzling case, fat necrosis was recognized by the presence of two outlying fat lobules which presented broad opaque spots of proliferating fat cells. The central position of the lesion strongly resembled carcinoma. However, one must be prepared to meet both carcinoma and traumatized fat tissue in the same breast. But why not resort at once to frozen sections? The reasons are that one must previously choose on gross examination the tissue to be sectioned, and when frozen sections are made the diagnosis may still be difficult.

"The microscopic structure of inflamed fat tissue in the breast strongly resembles alveolar carcinoma, especially in the later fibrous stages, when one encounters proliferating fat cells almost exactly reproducing the small alveoli of carcinoma lying in cicatricial

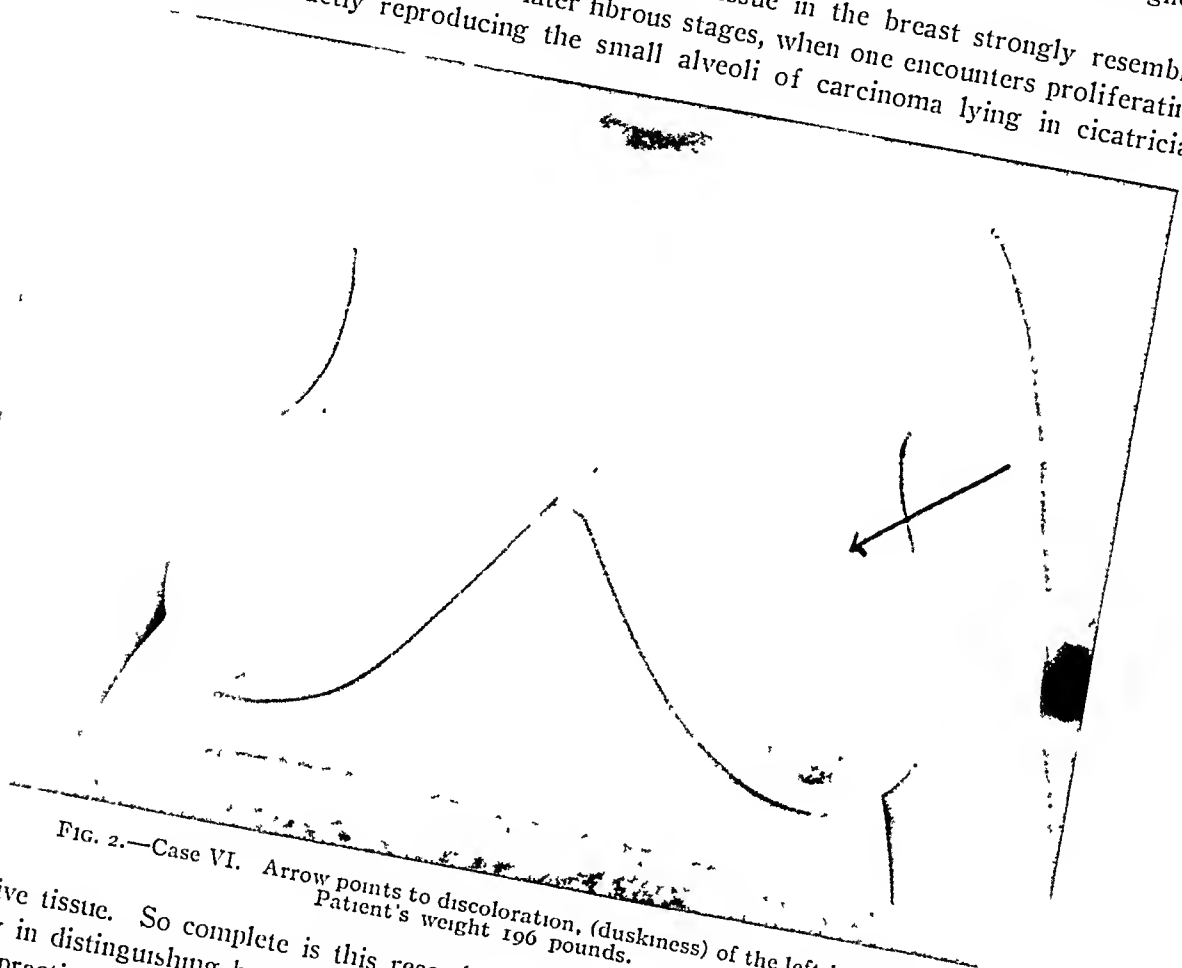


FIG. 2.—Case VI. Arrow points to discoloration, (dusky) of the left breast.
Patient's weight 196 pounds.

connective tissue. So complete is this resemblance that an expert microscopist may have difficulty in distinguishing between the two conditions. In frozen sections this difficulty may be practically insuperable, and there is little doubt that errors in the diagnosis of mammary cancer have occurred from this source. Usually the microscopic section furnishes a correct interpretation at once from the presence of much cellular overgrowth, fibroblasts mingled with lymphocytes, empty spaces once filled with fluid fat (oil cysts), formation of many phagocytic giant cells (Figs. 13 and 15), and wide areas of proliferating fat cells.

"In fibrous stages more reliance may be placed on the general lack of activity and lack of hyperchromatism in the cells. From some forms of cellular carcinoma with secondary degeneration and rich infiltration by lymphocytes, fat necrosis may be distinguished only by the exercise of great care. Wide sheets of polyhedral proliferating fat cells may almost exactly reproduce portions of cellular so-called "Medullary" carcinoma. The best paraffin sections are called for in this work."

The clinical history, physical findings and pathology of Cases I, II, III, IV and V have been described in previous communications of the authors.^{7, 8}

The following four cases have entered the Breast Clinic at the Memorial Hospital during the past two years:

CASE VI.—I. H., married, female of forty-eight years. Was admitted April 23, 1923, complaining of a lump in the left breast. (See Fig. 2.)

Mammary History.—Five months before admission, while carrying a picture frame under her left arm, she fell headlong down a flight of stairs, landing eight steps below. As she struck the stairs, there was an impact of the corner of the frame against her left breast, causing a pain of such severity that she fainted. Almost immediately swelling and ecchymosis appeared at the site of the injury. The patient consulted her physician who



FIG. 3.—Case VIII. Short heavy woman of 160 pounds.

told her "a blood-vessel had burst." The major part of the swelling was present for a month, with gradual diminution in size, leaving a lump in the breast that had persisted to the time of admission. The "black and blue" area gradually increased in size until it involved the entire breast and a portion of the adjacent lateral chest wall below the axilla.

Physical Examination.—The patient was an obese woman in good general condition. Her weight was 196 pounds. General examination was negative.

Breasts.—Over an area 7 cm. in diameter, the skin of the upper inner quadrant of the left breast had a slightly brownish discoloration. The skin was definitely attached to a deep-lying tumor situated 15 cm. above the nipple level and measuring 6 x 8 cm. The entire breast and tumor moved freely on deeper structures. The tumor was hard though somewhat resilient and in two portions the edges were sharply defined. There was no retraction of the nipple. In both axillæ large moderately firm nodes could be palpated. No supraclavicular nodes were palpable.

Provisional Diagnosis.—Attention was directed especially to diagnosis of traumatic fat necrosis because of the type of breast and the accurate history of trauma.

Operation.—Under one-half per cent. novocaine, the tumor was excised, going well beyond its circumference. On section there was no evidence of malignancy. The wound was closed save for a small split within tube.

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Pathology.—Report by Dr. James Ewing. "Area $3.5 \times 1.5 \times 1.5$ cm. (See Fig. 7) beneath the skin which is adherent by fibrous strands, is opaque yellowish and brown, with small cysts fading into fat tissue, and showing some whitish new tissue about parts of the lesion. Sections (No. 6859) show a great variety of processes connected with fluidification and necrosis and absorption of fat; and the reactive productive inflammation which accompanies them. Giant cells of very large size are very numerous and form large sheets lying between streaks of new connective tissue. There are many small oil cysts surrounded by lenticular giant cells. Some areas show beginning liquefaction and necrosis of fat. The amount of new connective tissue is moderate. Everywhere there is infiltration with hemorrhagic detritus, and about the periphery of the lesion are many very heavily pigmented cells. Areas of proliferating fat cells give an appearance not unlike carcinoma."

Post-operative Course.—The post-operative course was uneventful, the patient being discharged from the hospital one week after operation.

CASE VII.—J. N. (See Fig. 5) married, female of forty-four years, was admitted to Memorial Hospital, July 3, 1923, complaining of a lump in the right breast.

Mammary History.—Patient had had a painful sensation in the right breast appearing intermittently over a period of many years. About eight years previously she was under observation in the Memorial Hospital for a time on account of these breast symptoms, but no tumor was then present. Two weeks before admission she noticed some retraction of the right nipple and upon palpation felt a lump in the right breast. There was no history of trauma to the right breast.

Physical Examination.—Patient was an obese woman in good general condition. Her weight was 181 pounds. There was slight systolic murmur over the precordium. At the basis of the lungs occasional crackling râles could be heard.

Breasts.—The breasts were very large and fat. Above the right breast near the third costal sternal junction was a scar of a former burn. The right nipple was elevated and retracted. There was no skin adherence. Situated in the mid-portion of the right breast slightly above the nipple level, was a hard mass measuring 5 cm. in diameter. There was no attachment to chest wall. Neither axillary nor supraclavicular nodes were palpable. The opposite breast was negative.

Provisional Diagnosis.—Because of the stony hardness of the tumor, and the elevation and retraction of the nipple, we felt that we were dealing with an early carcinoma of the breast. The chest plate was negative for metastasis to the lungs. A pre-operative, low



FIG. 4.—Case IX. Breasts unusually heavy in comparison to remainder of body. Weight 186 pounds.

voltage X-ray cycle of five treatments was given over the breast, axilla and supra-clavicular regions.

Operation.—We were so certain that the case was one of mammary cancer that a radical breast amputation with removal of muscles and axillary contents was performed.

Pathology.—Report by Dr. James Ewing. "The process consists of a chronic inflammation in fat tissue, but no signs of carcinoma can be found. The tissue shows small areas of partly liquefied and saponified fat, which is granular, amorphous and bluish staining. About these areas there is very active growth of cellular connective tissue and granulation tissue in which many rather hyperchromatic spindle cells are found.



FIG. 5.—Case VII. Weight 181 pounds.

Among these are many giant cells of small and large size, some inclosing small masses of fat. Just about the areas of fluid fat the cells are large and polymorphonuclear. There are no signs of carcinoma. The whole area of fat necrosis covers about 3 cm."

Post-operative Course.—The post-operative course was tragic. During the operation the patient had taken the ether poorly, as shown by frequent obstruction to air passage with consequent cyanosis. However, she left the operating room in good condition. Three hours later the patient was again cyanosed, had Cheyne-Stokes respiration and could not be aroused. Stimulation was strenuously applied and artificial respiration kept up for an hour and a quarter, but without avail. Death was probably due to cardiac decompensation. No autopsy was permitted.

CASE VIII.—S. S., married, female of thirty years, came to the Memorial Hospital, July 9, 1923, complaining of a lump in the right breast.

Mammary History.—(See Fig. 3) Had had three lactations, each lasting almost seventeen months, the last one occurring two years before admission to the hospital. Approximately three months previously the patient first noted a small lump in the inner aspect of the right breast. The mass increased in size and was slightly painful. There was no history of trauma and lues was denied.

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Physical Examination.—The patient was a short corpulent woman. The chest examination was negative except for a systolic apical murmur which was not transmitted. Her weight was 160 pounds.

Breasts.—The breasts were large, soft, fat and pendulous. The nipples protruded and were on the same level. Along the mesial portion of the right breast there was a tumor 5 x 3 cm., which was firm, but not as hard as carcinoma. Skin was not attached to the tumor. There was no nipple retraction. One small node could be palpated in right axilla.

Provisional Diagnosis.—We believed that we were dealing with a benign tumor, but on account of its firmness malignancy could not be excluded. Therefore, we decided to do

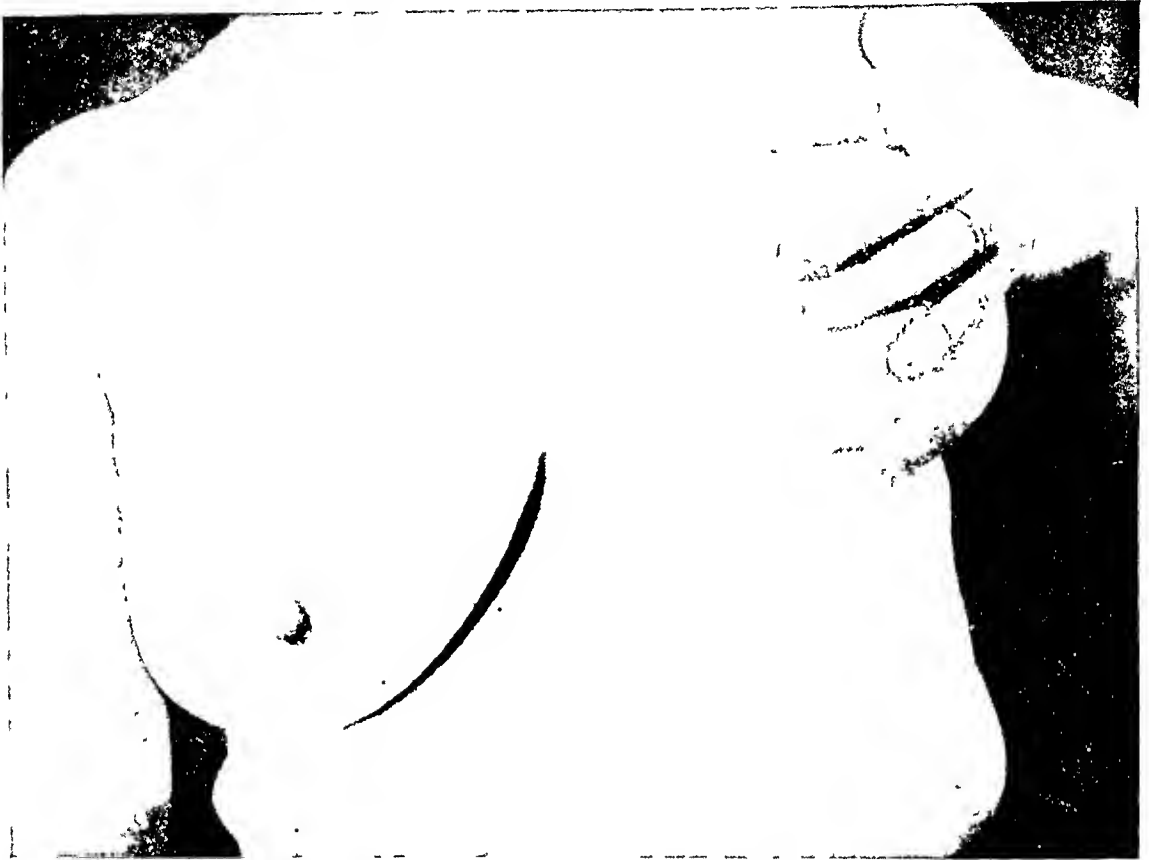


FIG. 6.—Case IV. Shows the adherence of the tumor to the overlying skin. In this case the nipple was pulled downward toward the chest wall. The skin adherence and pulling of the nipple exactly simulated carcinoma.

a local excision of the tumor including a wide surrounding zone, basing further procedure upon the gross appearance of the section.

Operation.—July 20, 1923. Ether anæsthesia. A wide excision of the tumor was made. The mass was partly composed of a smoothly lined cyst 7 x 5 cm. In one portion there was a projection of necrotic brown tissue into the cyst. From the cut lactiferous ducts there exuded a thick yellow creamy material. Gross examination revealed no evidence of malignancy.

Pathology.—By Dr. James Ewing. "Section shows a very active inflammatory reaction about liquefied fat. There is very extensive proliferation of fat cells producing areas in which these polyhedral cells, resembling cancer cells, are found in solid diffuse sheets. There are some points of liquefied fat about which giant cells form. On the periphery of the lesion there is much new growth of connective tissue. There is no sign of carcinoma."

Post-operative Course.—The patient made an uneventful convalescence.

CASE IX.—A. G., married, female of forty-five years, was admitted to Memorial Hospital, November 23, 1923, her only complaint being the presence of a lump in the left breast.

Mammary History.—(See Fig. 4) Patient stated that about four weeks before she accidentally noticed a lump in her left breast. It had remained stationary in size and was entirely painless. She had never received a severe trauma to the breast.

Physical Examination.—Patient was a corpulent woman in good general condition. Her weight was 186 pounds. Except for the breast tumor her examination was negative.

Breasts.—Situated 2.5 cm. from edge of areola in the direction of five o'clock from the nipple, was a stony hard tumor measuring 1.5 x 1 cm. The mass was just beneath the skin to which it was distinctly attached. The nipple was slightly retracted and definitely elevated. Throughout the entire breast there was a condition of chronic mastitis.

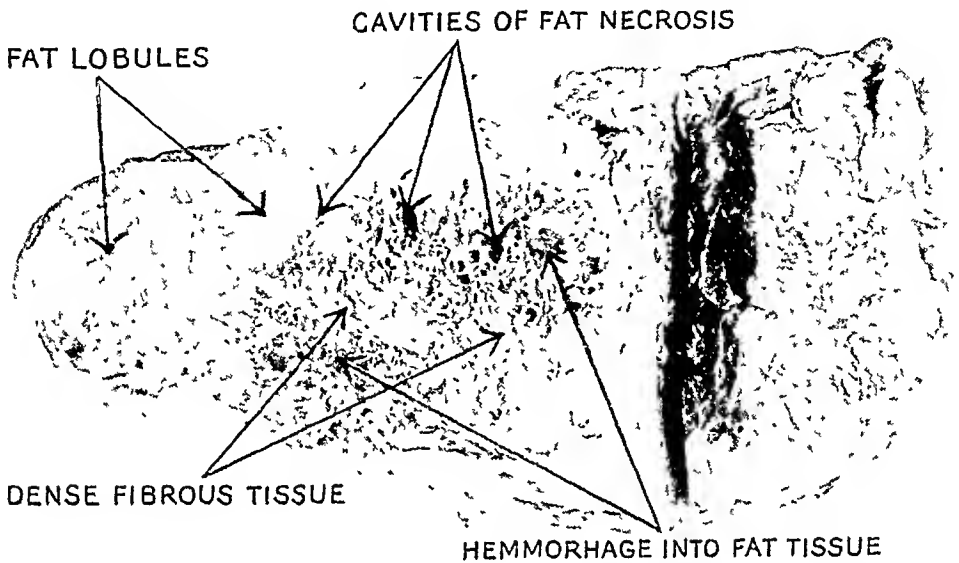


FIG. 7.—Case VI. Gross specimen four months after the injury. There is an extensive area of hemorrhagic products in the fat tissue. Numerous small cysts of fluid fat are scattered throughout.

Some years ago the patient had an abscess in the breast, which may account partially for the nipple retraction and elevation. There was an enlarged firm node in the left axilla.

Provisional Diagnosis.—Because of the tumor hardness, nipple elevation and retraction and the firm axillary node, we felt that we were dealing with a carcinoma of the breast, but the mass seemed so superficial that a definite diagnosis seemed impossible. X-ray examination of the lungs was negative for metastasis. A pre-operative cycle of X-ray treatments over the breast and drainage areas was given prior to operation.

Operation.—Under ether anæsthetic, a wide excision of the tumor was carefully made. Upon section the tumor was as hard as the average carcinoma, but contained two small cystic areas lying in dense fat tissue. (See Fig. 8.) Throughout the glandular tissue lying outside the tumor area were numerous small bluish cysts. We believed we were not dealing with carcinoma, but probably with a fat necrosis. The wound was completely closed save for a small split rubber tube drain.

Pathology.—Report by Dr. James Ewing. "The nodule shows chronic inflammation about a small area of liquefied fat. There is active growth of fat cells and fibroblasts with englobment of fluid fat. Formation of a few giant cells and infiltration of lymphocytes. There are a few minute cysts evidently containing fluid fat. There is no sign of carcinoma."

Post-operative Course.—The post-operative course of this case was entirely uneventful.

The following case report has been furnished us through the kindness of Dr. A. R. Kilgore, of San Francisco.

CASE X.—B. A., single, female of fifty-nine years. History was negative, except at

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the age of forty-five years she had an artificial menopause following hysterectomy for fibroids.

Mammary History.—Four days before her admission to the hospital she accidentally noticed a small lump in the upper outer quadrant of the left breast. Since discovering the mass she had been conscious of a slight tingling or burning sensation.

Physical Examination.—Breasts were symmetrical, large, fatty but not pendulous. There was no nipple retraction. In the upper outer quadrant of the left breast, there was a pea-sized subcutaneous nodule which was very hard. This mass was freely movable in the subcutaneous tissue. Immediately beneath it and apparently within the breast tissue



FIG. 8.—Case IX. Gross specimen. 1. Skin of breast. 2. Area of fat necrosis 1.5x1 cm. It is stony hard. There are a few cysts of fluid fat. 3. Fat lobules. 4. Breast tissue.

itself, was a lump the size of a lima bean, also freely movable. Upon pushing the breast toward the midline, a definite and well-marked skin retraction could be demonstrated. This was markedly limited to an area 1 cm. square over the nodule. No axillary nodes could be palpated.

Operation.—August 10, 1921. Novocain anæsthesia. The nodules were completely excised, together with a good zone of surrounding tissue. Cross-section of the specimen showed that the superficial nodule was composed of whiter fat than the normal yellow fat tissue surrounding it, the color resembling that of beef suet. The larger deeper nodule was not connected with the first. Upon section it had a similar appearance, except that it presented minute broken down areas, one of which was 2 mm. in diameter and contained degenerated material. This large second nodule seemed to be fat tissue, but of very much harder consistence than the surrounding normal fat. It was well circumscribed but not encapsulated.

Pathology.—Report by Dr. G. Y. Rusk. (Fig. 15.) "Microscopic examination of breast tissue shows a relatively large amount of fat and only occasionally traces of parenchyma. The few islands of breast tissue observed show a slight periductile infiltration with lymphocytes and occasional plasma cells. The main mass of tissue consists of fat with connective tissue septa. In the latter, one again finds evidence of old inflammatory reactions. The principal reaction occurs in the fat itself and consists of a marked

infiltration of the fat tissue with cellular fibrous tissue, mononuclear cells varying greatly in size, and larger ones having a pale, very finely reticulated cytoplasm suggesting developing fat cells, and other structures varying from cells with two or three nuclei, up to large nucleated syncytial masses. In going over the sections a single mitotic figure was observed. In a few places small slits are seen in the tissue, suggesting slight cholesterol deposit. The cytoplasm of the giant cells varies, sometimes appearing like that described in the mononuclear cells, and again being more eosinophilic and compact. The giant cells are distinctly of the foreign body type. Occasionally groups of eosinophiles are seen



FIG. 9.—Case V. Shows appearance of gross specimen eight years after the injury. The cyst was 2.5 cm. in diameter. The cyst wall was stony hard and seemed partially calcified. The cyst was filled with thick grumous material and small stones of calcification. The stones show well in this photograph.

among the smaller mononuclear cells and also a few polymorphonuclear neutrophiles, being apparently a more acute stage of the process.

“Diagnosis.—Reparative reaction following either infection or trauma in fat tissue.”

Pathological report by Dr. James Ewing. “The sections show a chronic productive inflammation of fat tissue which is characteristic of the reaction of fat tissue to trauma. The fat in many cells is being absorbed by a proliferation of clear polyhedral cells within the fat cell membrane. This proliferation results in gradual replacement of the fat by the new cells. There is also considerable growth of new spindle fibroblasts, in the more advanced stages of the process. At several points there are small cysts, originally filled with fluid fat, about which many giant cells of various sizes are forming.”

The following case report has been furnished us through the kindness of Dr. A. Hyman of New York City.

CASE XI.—A. M., married, German female, fifty-three years of age, was admitted to Mount Sinai Hospital on December 12, 1922. She had had three children and one miscarriage, and four years before admission a hysterectomy for complete uterine prolapse. Otherwise her past history was negative.

Mammary History.—There had been no previous history of abscesses of the breast, of caked breast or cracked nipples. Her chief complaint upon admission was the presence of a lump in the left breast. One month before admission, in attempting to close a window, it suddenly gave way and struck her in the left breast. The site of the injury was painful and a few days later the patient noticed a lump where the injury had been

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received, over which the skin was ecchymotic. This mass in the breast had persisted up to the time of admission, but had not increased in size and had been painless.

Physical Examination.—The patient was a well nourished adult female of stocky frame. Approximate weight was 170 pounds. General examination was negative.

Breasts.—The breasts were large, pendulous and contained much adipose tissue. In the upper middle quadrant of the left breast about 6 cm. above the nipple, there was a small irregular hard mass, about 3 cm. in diameter. This mass was not tender, skin over it was not attached and the growth itself was fairly movable. There was an enlarged lymph-node which was not hard in the left axilla. Wassermann examination was negative.

Provisional Diagnosis.—A pre-operative diagnosis of a non-malignant breast tumor was made and the possibility of its being traumatic fat necrosis was noted on the chart.



FIG. 10.—Case III. Gross specimen ten years after hypodermoclysis. There are numerous cysts, the largest 2.5 cm. in diameter. Walls of the cyst are thick and hard. Cyst contents, sand sediment of calcification.

Operation.—December 9, 1922. Dr. A. Hyman. The tumor was excised through a small radial excision. Frozen sections showed areas of fat necrosis. The wound was immediately closed.

Pathology.—By Doctor Mandlebaum, of Mount Sinai Hospital. "Specimen consists of a mass of breast tissue, apparently fat, received in formalin. Microscopical examination shows adipose tissue with considerable increase in the amount of fibrillar connective tissue between the fat cells. In addition, there are numerous foci of lymphocytes present, which represent areas of inflammation of a chronic type, and many giant-cells of inflammatory character. (December 11, 1922)."

Patient was again operated upon June 8, 1923. Pathological report by Doctor Mandlebaum.

"Specimen consists of adipose tissue received in formalin. The microscopical picture is quite similar to that noted in the former examination, excepting that the process is considerably more advanced. The interstitial connective tissue is quite dense and compact, the giant-cells are more numerous, and in addition, many fat cells are seen presenting the typical picture of necrosis. Some of these fat cells are filled with a granular detritus, while others show fine needle-like crystals. The diagnosis of fat necrosis can therefore be established. (June 8, 1923)."

The following case report has been furnished through the courtesy of Dr. A. A. Berg, of New York City.

CASE XII.—M. D., married, female, sixty years of age, was admitted to Mount Sinai Hospital early in March, 1923. She had had two children; her past history otherwise was negative.

Mammary History.—About three months before admission the patient suffered an injury to the right breast, followed by the development of a large hæmatoma. The hæmatoma finally disappeared after a period of several weeks. About six weeks after the disappearance of the hæmatoma, a swelling appeared in the right breast over the same area.

Physical Examination.—The patient was of moderate adiposity.

Breasts.—There was a tumor in the right breast, smooth on its surface, pure, tense but not fixed to the skin or pectoral muscle. No palpable axillary nodes.

Provisional Diagnosis.—A provisional diagnosis of traumatic cyst of the breast was made, and consent given for operation.

Operation.—March 14, 1923. Dr. A. A. Berg. The tumor was excised.

Pathology.—By Doctor Mandlebaum, of Mount Sinai Hospital.

"Microscopical examination of specimen removed from the breast of Mrs. D. shows small cysts containing red blood cells, fatty crystals and giant cells. (Phagocytes.) There is nothing present of malignant character. Diagnosis: Fat necrosis due to trauma."

The following two cases have been furnished us through the courtesy of Dr. Joseph C. Bloodgood, of Baltimore.

CASE XIII.—M. B., married, female of about fifty-six years of age, was admitted to the hospital March 31, 1920, under the care of Dr. J. M. T. Finney. She had suffered cardiac palpitations for years. A hysterectomy had been done in 1917 for irregular uterine bleeding.

Mammary History.—Patient had had pain in both breasts for seven years, but the masses in the breasts had been noted but for two weeks.

Physical Examination.—Breasts were symmetrical and large. There were no palpable axillary nodes. There was a lump in the left breast in the upper outer quadrant 2.5 x 1.5 cm. The skin over it was slightly reddened with definite skin retraction and dimpling, was tender and was hard in consistency. There were two masses in the right breast, the first in the upper outer quadrant just beneath the skin, which was 1 cm. in diameter. The skin over it was slightly reddened. In the lower outer quadrant was a mass 3 cm. in diameter, the skin over it somewhat reddened. The mass itself was tender, irregular in outline and hard. Both masses showed skin retraction and dimpling.

Provisional Diagnosis.—Benign tumors of the breast. The following note by Doctor Finney is of interest. "This case was a most interesting one from a diagnostic standpoint. I have never seen anything quite like this condition. I was sure it was not malignant, although many of the characteristics of malignancy were present. It was simply a localized area of inflammation of fat in the breast. This inflammation involved the skin, producing retraction and dimpling, together with the pig-skinned appearance so often seen in connection with cancer."

Operation.—April 9, 1920. Doctor Finney. Exploratory incision. Excision of tumor from both breasts.

Pathology.—Report by Dr. Joseph C. Bloodgood. "Grossly the masses have not the appearance of cancer. From the left breast is an area of skin 7 x 4 cm. removed with a mass of fat. Just beneath the nipple you can see a little irregular non-encapsulated area, distinct from the surrounding fat, which palpates like cancer, but has no other gross markings of cancer.

"The area removed from the right breast is 1 cm. in diameter, irregular, no capsule, feels hard like cancer, but has not the appearance of cancer.

"Frozen section shows tumor composed of fat with a good deal of cellular fibrous tissue. No gland parenchyma. No histological evidence of cancer. There is a cellular granulation tissue in fat, numerous leucocytes, larger cells which might be called epithelial cells, which suggest to me plasma cells or endothelial lymph vessels. I even find here and there areas of fat necrosis. The tumor is apparently due to a chronic inflammatory reaction in the fat, with production of connective tissue and fibrous tissue."

Post-operative Course.—Patient well four years after operation.

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CASE XIV.—L. M., White female, thirty-nine years of age, was admitted to St. Agnes' Hospital in June, 1923.

Mammary History.—Two weeks before admission, woman observed a tumor in the breast, outside the nipple zone. Patient had very large breasts which were very fatty.

Physical Examination.—By Dr. Joseph C. Bloodgood. "Inspection was negative. Breasts very large. Well developed nipple. No warts on nipples. No varicocele beneath nipples. Not the shotty breasts. As I pushed both breasts toward the sternum I saw three dimples in the nipple zone of the upper hemisphere, and right beneath this area I could palpate a mass that extended to the areola. It was superficial as if it were in

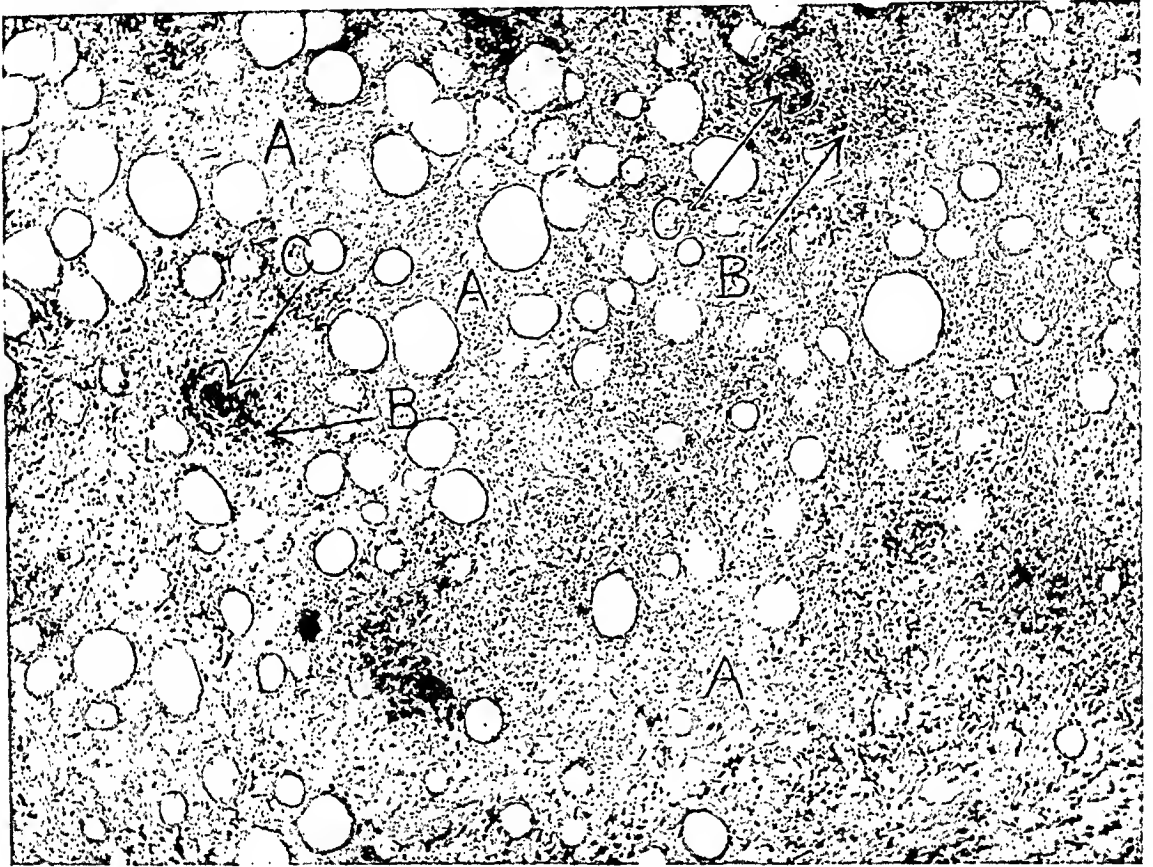


FIG. 11.—Photomicrograph. A. Necrosis. B. Lymphocytic infiltration. C. Obliterating endarteritis.

subcutaneous tissue. Felt like a bunch of worms. Leathery. It was irregular in outline. Nothing to be palpated in the axilla. Little tenderness."

Provisional Diagnosis.—"Breast benign tumor. Subcutaneous calcified and inflammatory lipoma. Tumor felt like dilatation of ducts outside of nipple area and was clinically malignant because of dimpling of skin."

Operation.—June 7, 1923. Doctor Bloodgood. Excision of area with dimpled skin, thinking it was dilated ducts. The mass was then bisected and diagnosed as calcified lipoma.

Pathology.—Report by Doctor Bloodgood. "On exploration, proved to be fat stroma with a number of subcutaneous areas but no calcification.

"*Microscopic.*—Section 2, subcutaneous fat, we have fat and in the fat irregular areas of lymphoid reaction apparently surrounding fat necrosis, perhaps the next stage to the necrosis would be the calcification. Beneath this are what we have originally diagnosed: dilatation of ducts, so the clinical diagnosis was part right and the gross diagnosis was part right. I did not see dilatation of ducts in the gross. Section 3, fat beneath, 2, largely breast with lymphoid areas and fat necrosis as in 2, and dilatation of ducts and lobules of breast. Section 4, fibrous tissue beneath skin, same fat, same lymphoid areas. Section 5, breast tissue and fat, same fat, same lymphoid areas fat necrosis. Here and there dilatation of ducts, fibrous tissue."

Life History.—A severe trauma to the breast produces a rupture of fat cells, and at the same time a rupture of small blood-vessels, with extravasation of blood into the tissues. If this hemorrhage occurs near the surface, ecchymosis may be apparent beneath the skin; however, if a hemorrhage occurs in deeper tissues, as in the hypodermoclysis cases, no ecchymosis may be observed. Necrosis of the fat tissue appears soon after the injury, and giant cells have been found in the tumors at the end of five weeks. An obliterating endarteritis may appear a few months after the injury. See Case I,

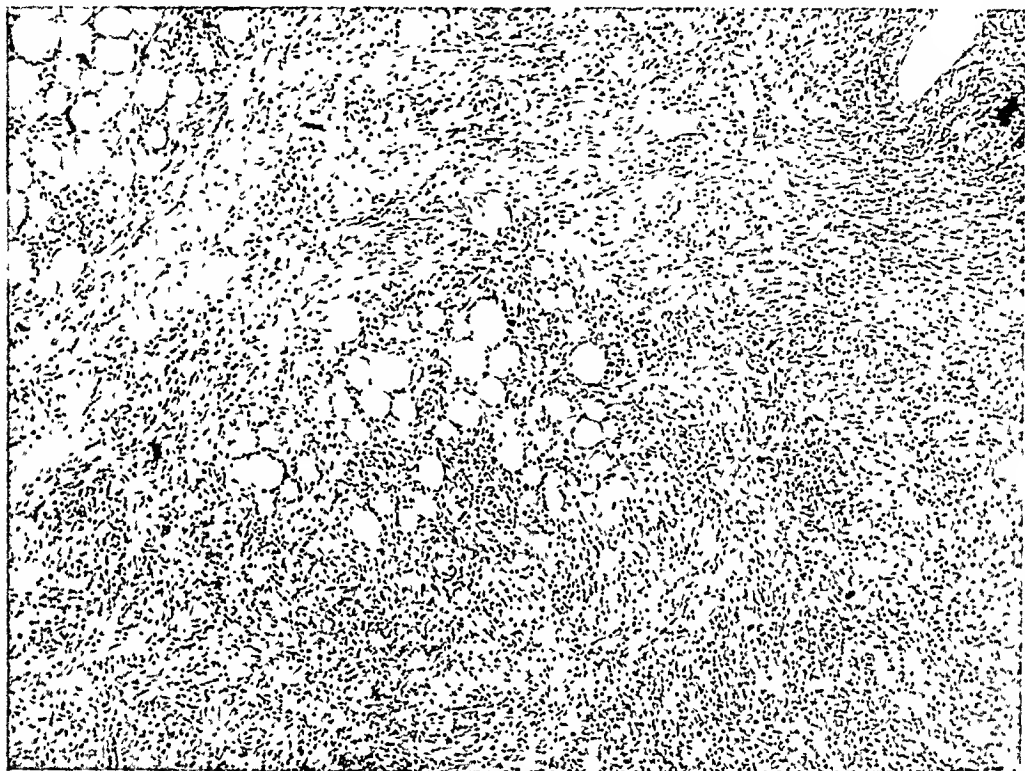


FIG. 12.—Case I. Photomicrograph showing about fat cells, an inflammatory infiltration with a marked productive reaction of the fibrous tissue.

showing marked changes of this character three months after receipt of the trauma. (Fig. 11.) In no early case was there an oil cyst of any large size. Several years after the beginning of the process, as seen in Cases III and V (Figs. 9 and 10), definite large cysts 2.5 cm. in diameter, with a thick laminated fibrous wall, may be expected. (Fig. 14.) Therefore, multiple cysts of small size are usually seen early, but a small number of larger cysts are to be expected later in the course of the disease. After several years these cystic cavities may contain a mixture of small and large calcareous masses, sometimes as fine as sand, other times as large as 5 mm. in diameter, mixed with a thick, brownish, sticky detritus. Had these tumors been left undisturbed, it seems possible that the entire cyst contents and cyst wall would have become a solid calcareous mass.

Incidence.—Our former study gave an incidence of traumatic fat necrosis of the breast in comparison with primary carcinoma of the breast of 1.8 per

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cent. The additional cases occurring in the clinic have now raised this percentage figure to 2.5 per cent. Our own experience with this disease, coupled with the reports of other observers, proves that it is not uncommonly encountered in dealing with tumors of the mammary gland.

Age.—The youngest patient of the twenty under report was thirty years of age, the oldest sixty-three. Therefore, the lesion is encountered in the so-called cancer decades and most often in mid-life. The reason for its occur-

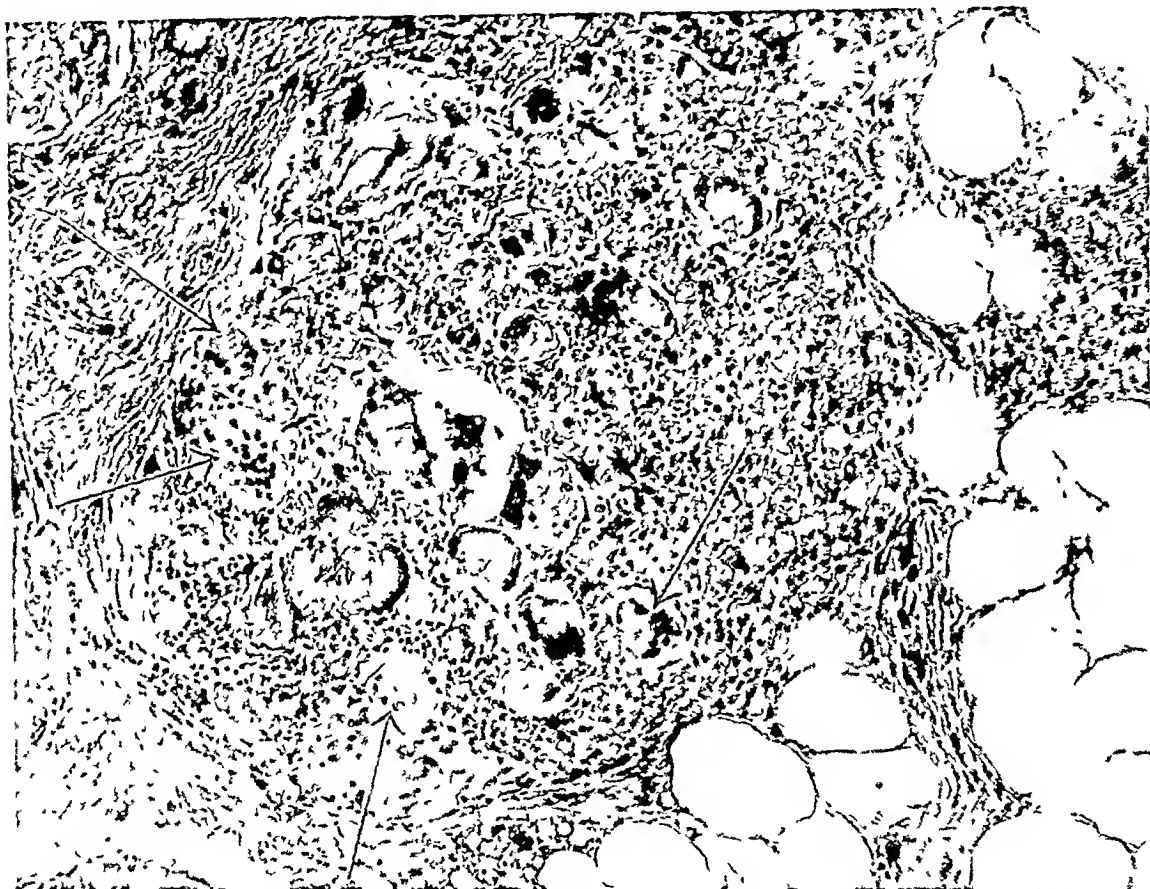


FIG 13.—Case VI Photomicrograph showing nests of large and small giant cells.

rence in mid-life is probably due to the fact that in youth and old age an excess of fat deposit in the breast is much more rare.

Weight.—In practically every incidence the patient was far beyond the normal weight. The importance of this factor is illustrated by the following table:

Weight Chart

1 Case	211 pounds
3 Cases	190 to 200 pounds
3 Cases	180 to 190 pounds
1 Case	170 to 180 pounds
1 Case	160 to 170 pounds
3 Cases (short in stature)	150 to 160 pounds

In the cases in which it was recorded the average weight was 176 pounds.

Type of Breast.—Nineteen of the twenty cases had definitely obese breasts. As the disease occurs in unusually adipose individuals, one would expect to

encounter in such patients abnormally fat breasts. The breasts vary in type from those which are large and pendulous (Figs. 1, 2 and 3), reaching almost to the umbilicus, to those which are protruding and massive. (Figs. 4 and 5.) Such breasts are more readily subject to trauma and contain far more fat tissue than the average mammary gland.

Trauma.—The degree of trauma is usually severe. In one instance the

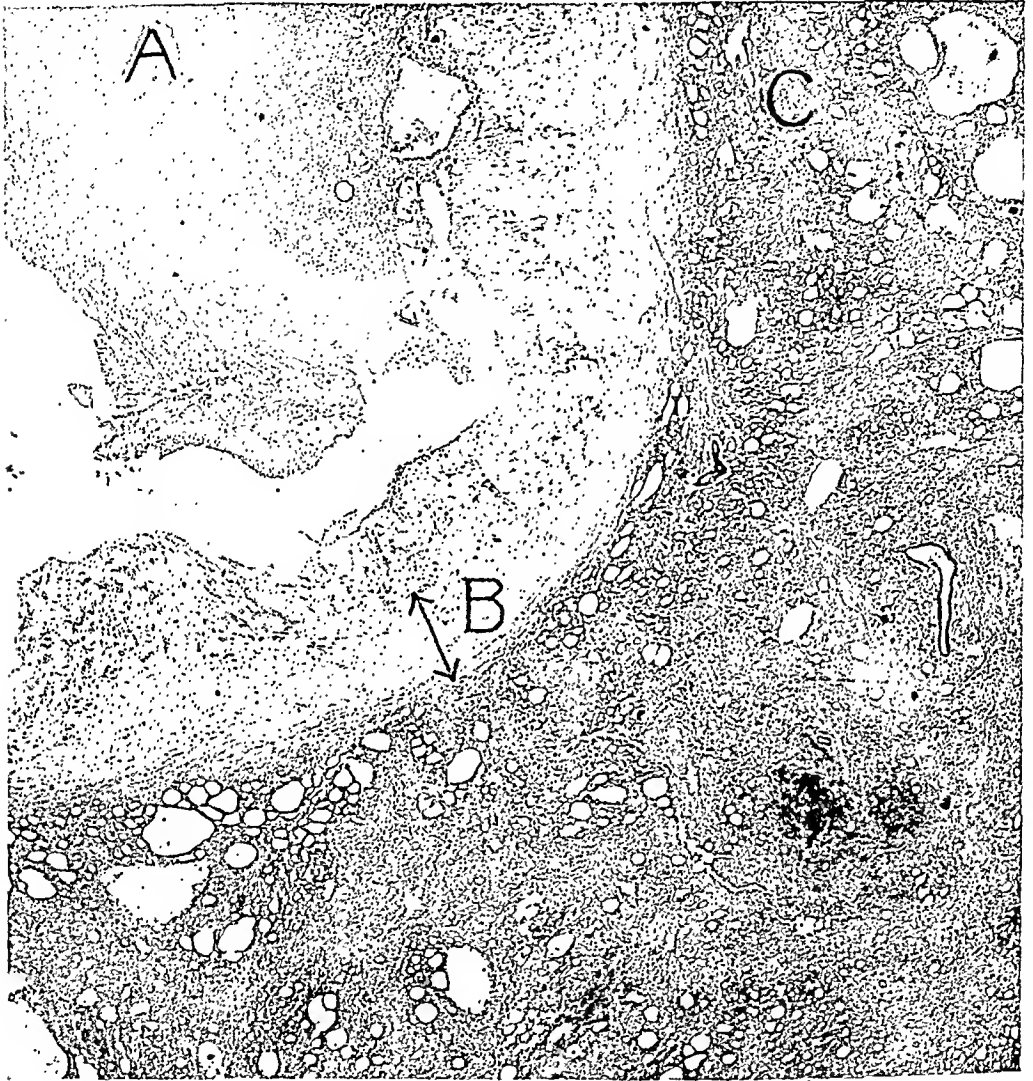


FIG. 14.—Case III. Photomicrograph of portion of 2.5 cm. cyst. A. Represents the fatty necrotic material which fills the cyst. B. Represents the cyst walls showing the laminated connective tissue structures. C. The outlying necrosis in that tissue.

patient fell downstairs with a picture frame under her arm, the corner of the frame striking the breast. Another patient fell thirteen steps, a trauma being inflicted upon the breast by the sharp corner of a pedestal at the bottom of the stairs. A third patient was struck violently in the breast by the point of an elbow. These instances illustrate the production of the lesion by a mechanical injury of marked degree. In three of the patients the trauma was furnished by a preceding hypodermoclysis, and we feel that a tumor

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developing in the breast following hypodermoclysis, is more likely to be due to fat necrosis than to any other type of lesion. However, in four of the cases in our series no definite history of trauma could be elicited, while in two other instances no statement was made as to presence or absence of trauma. In fourteen of the cases, or 70 per cent., the traumatic history was definite. As we have pointed out in a former contribution, the surgeon should assure himself that the site of trauma is identical with the location of the tumor.

Absence of Pain.—Traumatic fat necrosis of the breast is characterized by its painlessness. In but three instances was there any complaint of definite pain. However, there is a certain amount of tenderness in and about the breast following the receipt of the injury, but this symptom generally disappears in a short time.

Hardness.—This important symptom was present in fifteen of the twenty cases, and the stony hardness of fat necrosis is largely responsible for the difficulty of clinically distinguishing the lesion

from carcinoma. One of the cases under report, Case XII, was elastic in consistency, while Case XIV was described as of "leathery" feel.

Fixation to the Skin.—Skin adherence was present in fourteen cases, or 70 per cent. of the total number. The appearance presented by the skin attachment over the tumor may be identical with that seen in cases of mammary carcinoma, as is illustrated by Fig. 6, in which the appearance of the tumor followed a hypodermoclysis.

Nipple Retraction.—This sign is rarely present, occurring in but four of the cases, or but 20 per cent. In a tumor of long standing the absence of nipple retraction is of considerable importance in a differentiation from carcinoma, in which disease it is quite uniformly to be expected.

Attachment to Deeper Parts.—It seems probable that this sign is produced by the inflammatory reaction and subsequent fibrosis following a hemorrhage deep in the breast with the formation of adhesions to the pectoral fascia. This symptom was elicited but four times in the entire series, or but 20 per cent. It must be regarded a fairly inconstant symptom.

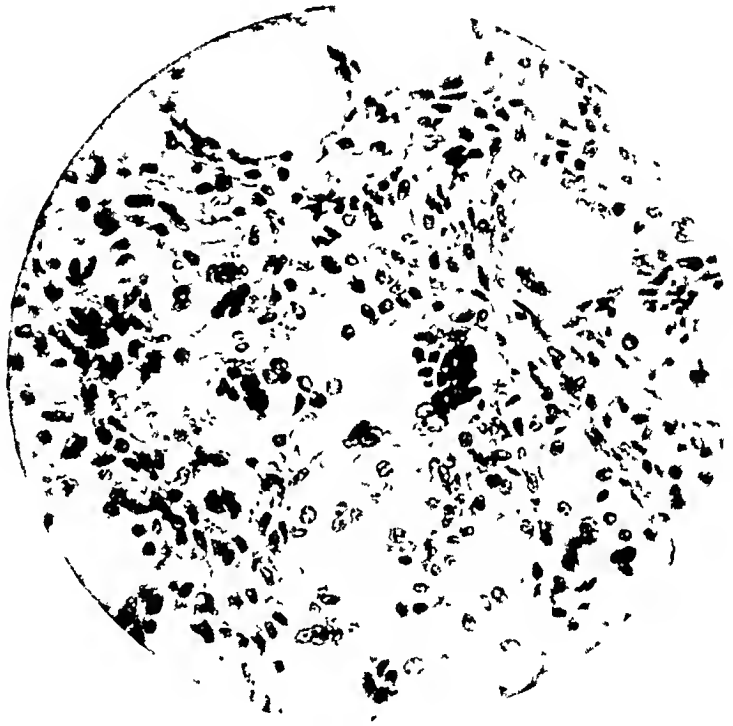


FIG. 15.—Case X. Photomicrograph showing large and small giant cells.

Axillary Nodes.—In the palpation of any axilla, and especially in the axilla of a fat woman, it may be impossible by the most painstaking examination to make out the presence or absence of lymph-nodes, or to determine their size and consistency. In no instance of the cases in this series were any nodes of hard consistence palpated prior to operation. In five instances small soft nodes were to be felt, but in the remaining fifteen cases palpation of the axilla was negative.

Size of the Tumor.—The tumor varied in size from a small nodule 1 cm. in diameter to a mass 6 x 8 cm. Therefore, the nodule of fat necrosis following trauma of the breast shows no constancy as to size. A nodule of a few centimetres in diameter is to be expected. We have never seen a large tumor produced by this lesion.

Period of Development following the Trauma.—Of the fourteen cases in whom a definite history of trauma was obtained, but one gave a history of an immediate appearance of the tumor following the trauma. In Case XI a tumor was recognized a few days after the injury, while in Case IV a month had elapsed following the receipt of the trauma. Upon the other hand, in Cases III and V there was a period of ten years and eight years, respectively, from the time of injury to the appearance of the mass in the breast. Therefore, no rule can be laid down as to the period of time between trauma and the recognition of the tumor.

Ecchymosis.—In eighteen cases a statement was made as to the presence or absence of ecchymosis, and in nine instances, or 50 per cent., the findings were positive. It is possible that in some instances a transient ecchymosis might have been unobserved by the patient.

Graphic Chart of Symptoms and Diagnosis

19 cases showed	fatty breast
15 cases showed	stony hardness
15 cases were	painless
14 cases gave history of	severe trauma
14 cases showed	skin fixation
13 cases were diagnosed	non-malignant
9 cases gave history of	ecchymosis
7 cases were diagnosed	cancer
5 cases had	soft axillary nodes
4 cases showed	nipple retraction
4 cases showed	deep attachment

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TABLE I.
Summary of Cases.

Authors	Age	Weight lbs.	Trauma	Pain	Tumor hardness	Obese	Nipple retraction	Skin fixation	Deep attachment	Axillary nodes	Ecthy- mosis	Duration	Pre-operative diagnosis
Case I. Case II. Case III.	52 36 40	190 211 191	++ ++ ++	0 0 0	++ ++ ++	++ ++ ++	0 0 0	++ + 0	+ + +	0 + 0	0 0 0	3 mo. 7 mo. 1 mo.	Ca. Ca. Non. Mal.
Case IV.	47	152	+	+	+	+	+	+	0	0	+	10 mo.	Non. Mal.
Case V.	54	180	+	0	+	+	0	+	0	0	+	3 wks.	Non. Mal.
Case VI.	48	196	+	0	+	+	0	+	0	+	+	5 mo.	Non. Mal.
Case VII. Case VIII.	44 30	181 160	0 0	0 +	++ ++	++ ++	0 +	0 0	0 0	0 0	0 0	2 wks. 3 mo.	Mal. Non. Mal.
Case IX.	45	186	0	0	+	+	+	+	0	+	0	4 wks.	Non. Mal.
Case X.	59		0	0		+		+	0	0	0	4 days	Non. Mal.
Case XI.	53	170	+	0	+	+		0	0	+	+	1 mo.	Non. Mal.
Case XII.	60		+			+	+	0	0	0	+	3 mo.	Non. Mal.
Case XIII.	56			+	+		+	+		0		2 wks.	Non. Mal.
Case XIV.	39					+				0			Non. Mal.
Case XV.	42	150?	+	0		+	0	+			+	5 days	Non. Mal.
Case XVI.	35	150	+	0	+	+	0	+	0	+	0	4 wks.	Non. Mal.
Case XVII. Case XVIII. Case XIX. Case XX.	36 63 34 53		++ ++ ++ ++	0 0 0 0	++ ++ ++ ++	++ ++ ++ ++	0 0 0 0	++ ++ ++ ++	0 + ? +	0 0 0 0	0 ++ ++ ++	3 wks. 6 wks. 1 mo.	Mal. Mal. Mal. Mal.

Diagnosis.—The clinical diagnosis of traumatic fat necrosis of the breast is often difficult, but in certain cases a correct diagnosis can be rendered before operation. The most important factors in the diagnosis of this condition are:

1. It always occurs in a fat breast.
2. It usually occurs in a corpulent subject.
3. A definite history of severe trauma can usually be obtained.
4. The tumor is painless.
5. In the vast majority of cases the consistency of the tumor is one of stony hardness.
6. Skin adherence is present in a large number of cases.

The differentiation from carcinoma is at times difficult. In those patients in whom the lesion has existed for several years carcinoma may readily be excluded. In more recent cases, extending over months or years, it may be impossible to distinguish the two conditions. Of the twenty cases, a diagnosis of non-malignancy was rendered before operation thirteen times. In seven instances a pre-operative diagnosis of carcinoma was made. The diagnosis of malignancy was therefore incorrectly rendered in 35 per cent. of the cases.

Treatment.—A non-traumatizing excision of the tumor, together with a reasonably wide zone of surrounding tissue, will yield a satisfactory result. It seems wise to emphasize the necessity of a non-traumatizing operation, for in a fat breast, injury to the adipose tissue may reproduce the lesion. We have seen one instance of traumatic fat tissue appearing in a scar following an excision of a benign tumor. In cases of long standing, if the surgeon feels fairly certain that he has correctly diagnosed the condition, no excision or treatment of any sort need be strongly urged. Especially is such an attitude justified if the patient is a little worried because of the tumor in the breast. In general, however, we feel that the wisest course is excision.

CONCLUSIONS

1. Traumatic fat necrosis of the female breast is a definite clinical disease.
2. Its importance lies mainly in its striking similarity to carcinoma of the breast, not only as to its clinical appearance, but also as to its gross and microscopical picture.
3. A correct diagnosis of the condition prior to operation can sometimes be made.
4. Surgeons should recognize this lesion and constantly be on the lookout for it.

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THE NEUROTIC OR IRRITABLE ABDOMEN*

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A NEUROTIC or irritable abdomen may be defined as one in which disturbances of the sympathetic nervous system cause undue irritability of the muscles of the gastro-intestinal tract, and often those of the abdominal wall, perhaps combined with cutaneous hyperæsthesia and exaggerated pain and tenderness. The condition sometimes arises from hysteria or from central lesions, but usually is due to pathology within the abdomen itself. With these local manifestations, and depending upon them, is frequently associated a general nervous irritability, manifesting itself in neuroses of various kinds.

Surgeons are familiar with these "irritable abdomens." Such patients are difficult to examine, owing to hypersensitiveness and undue contractility of the muscles. They are subject to spasm of the pylorus and to disturbances of the vascular system, the functions of the stomach, the liver, the intestines and other organs. When the abdomen is opened the bowel frequently is found to be so sensitive that it contracts spasmodically at the slightest touch. Owing to this "keyed up" condition, such patients easily become introspective, dwelling unduly upon their internal sensations, some even acquiring consciousness of their normal peristaltic activities—in other words, they develop into so-called neurasthenics.

In order to arrive at an understanding of the question under discussion, one must bear in mind that although the cranio-spinal and sympathetic nervous systems are quite distinct and have different functions, nevertheless they are intimately united in divers places, so that the activities of the one are readily communicated to the other. For instance, the spinal ganglia receive many visceral sympathetic fibres and also send fibres to the vegetative system, which, in turn furnishes numerous connections between the various spinal ganglia. It is important to note that the visceral connections do not seem always to take place with regularity, sometimes occurring with the ganglion above or with the one below, instead of with the one to be expected. One also should remember the bewildering intricacy of the abdominal sympathetic system, with its numerous ganglia and plexuses and their multitudinous connections. The whole jumble may be compared with the telephone-system of a large city, with its maze of wires to individual residences and its various intercommunicating local stations.

When the terminal sympathetic filaments in the mucous and muscular coats of the bowel (plexuses of Meissner and Auerbach) are stimulated *normally* by the passage of food, the proper ganglia are communicated with and peristalsis occurs. Connection is also established with the pylorus, with other involuntary muscles, and with numerous secretory glands and organs,

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thus regulating the complicated process of digestion. But if the stimulation is *pathologically* increased, these activities are exaggerated or otherwise disturbed; and, in addition, impulses may overflow to the spinal ganglia and through them to the corresponding cranio-spinal nerves, causing rigidity and tenderness of the abdominal walls. And, conversely, when over-stimulation of the central nervous system exists, as in great emotional excitement, derangement of the internal functions may result; in fact, a kind of "vicious circle" arises between the vegetative and somatic systems, in which an irritation of one reacts backwards and forwards, with augmenting intensity, between both of them.

When abdominal pain, rigidity and tenderness appear, they usually are found in certain areas corresponding to the normal nerve connections. Sometimes, however, as mentioned above, these connections are abnormal, so that instead of the proper spinal nerve receiving the stimulus, it may be the one above or the one below, thus causing confusion in the location of the internal trouble and possibly a mistake in diagnosis. In cholecystitis, for example, the tenderness and rigidity may be referred to the appendix, and in appendicitis, to the gall-bladder.

The existence of sensory sympathetic neurons is commonly recognized—afferent fibres carrying sensations of various kinds to the central nervous system—and it is known that abdominal colics depend upon these fibres; but the prominent part actually played by the sympathetic nerves in the transmission of pain is not so generally realized. As illustrations of this may be mentioned—pectoral and abdominal angina, various abdominal crises, and the pain connected with acute pancreatitis, the passage of biliary calculi, certain forms of gangrene of the extremities, ileus, spasm of the pylorus, gastric ulcer, etc.

Some recent observations have emphasized the intensity and stubbornness of such pain. For example, Salomon and Schwartz † report an instance of pre-senile gangrene of the toes accompanied by intense suffering, in which a femoral peri-arterial sympathectomy was performed under spinal anæsthesia. In spite of the absence of ordinary sensation, when the sympathetic plexus was pinched with forceps intense pain was felt in the neighborhood of the gangrenous area. A similar stubbornness also characterizes contractions of the unstriated muscles, as seen in spasm of the pylorus or intestine, which often persists during operation in spite of the most profound general anæsthesia.

An important fact to note in connection with irritable abdomen is that the sensitiveness of the sympathetic neurones is exaggerated unduly by most pathologic lesions, such as chronic appendicitis, gastric ulcer and cholecystitis, just as it is similarly increased in gangrene of the extremities.

In the light of what has been said, it may reasonably be concluded that the neurotic abdomen, with its many bizarre manifestations, both local and general, is dependent upon an abnormal activity of the sympathetic nervous

† Bull. et Mem. de la Soc. de Chir. de Paris, Nov. 20, 1923, p. 1310.

system, with its infinite ramifications and inter-communications, both with itself and with the cranio-spinal system.

While it is true that the physiologic and pathologic phenomena of the sympathetic nervous system still remain largely in obscurity, nevertheless we are beginning to accumulate enough illuminating observations to justify a certain amount of theorizing. Quite recently we have learned much regarding the curious effects of sympathectomy in a multitude of conditions, such as angina pectoris, bronchial asthma, exophthalmic goitre, causalgia, trifacial neuralgia, gangrene, Raynaud's disease, epilepsy, ulcer of the stomach, spasm of the pylorus, and various secretory abnormalities.

I now wish to call attention to several specific forms of irritable abdomen, of which the significance, perhaps, is not quite as generally understood as it should be.

Irritable Abdomen from Chronic Obliterating Appendicitis.—It often has been said that there is no such thing as chronic appendicitis; that what is known by this name really is a recurrent appendicitis—recurrent attacks alternating with free intervals. What we find in the intervals is merely the result of the periods of inflammation and not the inflammation itself.

There is, however, a true chronic appendicitis, which is not uncommon. It is represented by the familiar "obliterating appendicitis," a condition in which the inflamed mucosa gradually disappears, as in atrophic rhinitis, converting the organ into a cicatricial cord with only a minute lumen or even no lumen at all.

Obliterating appendicitis is a slow process, often extending over many years. It begins at the tip and progresses toward the base, with a sharp line of demarcation between the proximal diseased mucosa and the distal portion which already has become atrophic. There are seldom any acute attacks. It is an ever-present, ever-progressive, truly chronic inflammation.

Such an appendix often is associated with an irritable abdomen, characterized by spasm of the pylorus, hyperacidity, a tendency to intestinal colics, flatulence, biliary stasis, spasticity and hypersensitiveness of the abdominal walls, and general nervous instability.

Even after the chronic inflammation has spent itself, converting the appendix into a fibrous cord, the general and local symptoms often continue until an appendectomy is done. This has never been quite satisfactorily elucidated, although it might reasonably be supposed to be connected with the sympathetic fibres, which exist normally in the appendix in even greater numbers than in the intestine. In fact, many surgeons consider it so improbable that such a mere cicatricial string can be harmful that they fail to regard it seriously, and may even refuse to remove it. Its importance, however, is sufficiently recognized by others, although a proper dramatic effect is sometimes lacking at the exhibition of so insignificant an operative trophy.

Recently my attention has been called to the observations of Schweizer,

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Masson,‡ and others, who frequently have detected the presence of neuromata and other abnormal conditions of the sympathetic fibres in obliterated appendices, the fibres being greatly increased both in size and number ("appendicite neurogene"). It would seem reasonable to assume that the development of an irritable abdomen in such cases can be explained by the pressure of contracting fibrous tissue upon these pathologically altered nerves, which frequently have been "amputated" by ulceration, just as occurs with the somatic nerves in sensitive scars and amputation stumps. Hence the importance of cutting such appendices completely out of the cæcum instead of leaving a proximal end, as is often done. A similar explanation may also apply to other conditions associated with much fibrous tissue, such as chronic ulcers of the stomach. Masson even ventures to apply his hypothesis of nerve irritation to the entire intestinal tract, where the submucous plexus is sometimes subjected to conditions similar to those arising in the appendix, which, if true, would go far towards explaining many obscure phenomena.

Irritable Abdomen from Enlargement of the Mesenteric Lymph-nodes.—This disease, although quite common in children and young adults, is not recognized frequently by surgeons. It manifests itself by the presence of numerous small, soft lymph-nodes, seldom larger than a pea. They can be felt as smooth nodules, and seem as small reddish spots, scattered profusely through the mesentery. There is no alteration in the peritoneum, although there is frequently considerable clear fluid in its cavity. When we bear in mind that these nodes are surrounded by an intricate maze of sympathetic fibres, connecting with numerous plexuses and ganglia throughout the abdomen, it is not surprising that mesenteric lymphadenitis can give rise not only to muscular and other disturbances of the intestine itself, but also engender various reflex phenomena in quite distant parts, such as the pylorus and the abdominal wall.

The infecting agent probably enters through the more or less intact intestinal mucosa. Influenza seems to play a prominent part in the etiology, although other causes also exist, including tuberculosis, as I have frequently demonstrated by the inoculation of guinea-pigs.

The symptoms are typically those of an irritable abdomen, and often so suggestive of appendicitis that a differential diagnosis becomes uncertain. They consist of:—(1) Abdominal pain, tenderness and rigidity, which are moderate and diffuse, but with a predilection for the right, lower quadrant, due, perhaps, to the fact that the peripheral attachment of the mesentery runs in that direction. (2) Transient colics, from spasm of the intestine (during laparotomies it is interesting to observe how the bowel undergoes violent spastic contracture almost at a touch, like a sensitive-plant). (3) Various gastro-intestinal disturbances including pyloric spasm. (4) Loss of energy and flesh and a moderate rise in temperature together with nervous irritability.

‡ P. Masson, *Annales D'Anatomie Pathologique*, vol. i, No. 1, p. 3. "Appendicite Neurogene at carcinoides."

Irritable Abdomen from "Intestinal Grippe."—This occasionally occurs as a post-operative complication when an abdominal operation chanced to coincide with an attack of influenza. The consequences may be both perplexing and serious.

Following the operation, the patient complains of unusually severe pain around the centre of the abdomen. At first this is attributed to flatus, but sooner or later it becomes evident that the patient is seriously ill. The constant pain increases until it becomes almost unbearable, and is accompanied by a rise in temperature and pulse. The abdomen distends and obstipation develops, although it is possible, for a time at least, to obtain inadequate results with enemata and pituitrin. Vomiting is not a prominent feature, but there may be gastric dilatation.

At first nothing can be detected in the lungs, but if the patient lives long enough pneumonia appears, with characteristic cough and bloody expectoration. Involvement of the sensorium is common, beginning with restlessness and insomnia and terminating in delirium and coma. The mortality is very high, death usually resulting in from twenty-four hours to a week.

It will be noted that the outstanding features of the trouble are severe abdominal pain, distention and obstipation. The supervention of these things upon an operation renders the diagnosis puzzling, and the anxious surgeon easily may be led into a useless operation for a supposed organic obstruction, a perforation, an appendicitis, a cholecystitis, or a peritonitis.

Although I believed this definite, clearly defined post-operative complication was due to "intestinal grippe," I failed to grasp the reason for its peculiar manifestations, especially the intense and constant pain. The explanation has recently been given, however, by Colmer,[§] who cites three cases of grippe with such violent abdominal symptoms that laparotomies were done under the impression that organic intestinal obstruction existed. In each instance nothing was found but a marked spastic contracture of the jejunum, with dilatation of the remainder of the digestive tract. This seems to be a satisfactory explanation of the pain, having the advantage of not being a mere theory, but of being supported by operative findings.

Colmer suggests that this spastic ileus may be due to either disturbance of the central nervous system or to the irritation of sympathetic nerves by the enlargement of the mesenteric glands. I am strongly inclined towards the latter view, because I so often have seen local intestinal spasm in the presence of mesenteric lymphadenitis; and, furthermore, if the trouble had its origin in the central nervous system one would expect to find spasm of much greater length of bowel than is actually found. If Colmer's view is accepted, there would be excellent reason for the therapeutic use of antispasmodics, such as atropin, as has been done successfully in a number of reported cases.

[§] "Ueber spastischen Ileus bei Grippe." *Zentralblatt für Chirurgie*, Dec. 30, 1922, p. 1931.

STUDIES IN BILIARY TRACT SURGERY*

A SURVEY OF 130 CONSECUTIVE SURGICAL CASES

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A RECENT writer¹ has said, speaking broadly, "cholecystitis is a disease which begins in youth, but is first recognized and properly treated in old age. The importance of this subject in old age will be noted when it is remembered that every tenth old woman coming to autopsy shows gall-stones, while there are many more disclosing cholecystitis without stones."

These thoughts fit very clearly with a study made of 130 consecutive cases operated on for gall-bladder disease by various surgeons at the Methodist Hospital, Philadelphia. There was no selection of cases and the operations were not the work of any one surgeon, but were the consecutive cases operated on by all the members of the staff and the extra-mural surgeons as well. This is a series such as would occur in any of our hospitals of a similar character.

The series averaged 44 years in age, ranging from 15 to 76 years. The majority of stones and empyema cases were over 55 years, 110 were women and 20 were men. One hundred and thirteen were married and 17 were single. The average duration of symptoms was two and a half years, the range being from one week to fifteen years.

Pain was a universal and common symptom. In some it was continuous, in others intermittent. It was typical, with radiation from the right epigastrium to the right scapular region in 58 cases. It was restricted to the right epigastrium in 37 cases. A tender liver edge was the most prominent sign. In 17 cases the pain was described as boring in character and limited to the back. Ten cases of definite typical colic were described.

In 75 per cent. of the cases belching was a very prominent and early symptom and was associated very often with nausea, prostrating headache, and general weakness, which the patient usually termed "biliousness."

Constipation was noted with marked frequency, while diarrhoea was charted in 7 cases. Jaundice was noted at some time or other in 25 cases. Clay-colored stools were mentioned in 8 histories.

In the past medical histories—typhoid fever was mentioned in 10 cases, occurring from 6 to 40 years previous. Tonsillitis and sinusitis were charted in 25 cases. Appendicitis and intestinal disturbances were mentioned in 70 cases. Appendectomy had been performed upon 6 of the cases at some previous operation. Thirteen gave history of previous pelvic disturbance or operative interference for those structures. Nephropexy had been done previously in several women. Several cases showed right-sided pyelitis.

*Read before the Philadelphia Academy of Surgery, May 5, 1924.

The constitutional signs were: fever with chills, which usually subsided a few days after admission, except in deep phlegmonous and long standing stone cases.

The prominent physical finding in the quiescent stages was right upper abdominal tenderness, especially along the liver edge.

A definite mass or palpable gall-bladder was noted in only 7 cases.

Three cases showed lower abdominal signs, while definite note of "no tenderness" was made in a considerable number. Some of these latter showed marked stone formation at operation. In a number of cases, the myocardium was of poor character, not an unexpected finding in a series of persons, many of whom were past middle life, and showing hypertension and menopausal disturbances.

The Röntgen-ray examination was seldom more than suspicious or suggestive. Fairly definitely outlined and distended gall-bladders were reported in 15 cases. Possible stone presence was made in 12 cases. A definite report of stones was made in 4 cases only. The findings at operation, as a whole, far surpassed these conservative reports.

Bile was studied in a considerable portion of the cases. Results were bacteriologically negative in a large percentage of cases. Streptococcus (unidentified) was reported 6 times. Staphylococcus aureus was found in 2 cases, staphylococcus albus was found in 5 cases. Bacillus coli was found in 5 cases, in 1 of these bacillus coli infection of the right kidney was associated.

Many cases of gall-bladder disease probably originate early in life, and persist with no, or only vague symptoms. Diseased conditions of the gall-bladder or biliary tract may be divided into those in which gall-stones do not occur and those in which the occurrence of calculi in some part of the biliary system overshadows, by its presence, those other elements which may have a more important bearing than the stones themselves.

At surgical intervention,³ the condition of the gall-bladders themselves can be approximately summarized in 3 forms: (1) Gall-bladders of normal size and shape, with dark viscid bile, usually sterile; (2) dilated gall-bladders, showing a normal or only slightly abnormal structure, with usually an impacted stone in the neck or in the cystic duct; (3) large distended gall-bladders, the walls of which show moderate or marked grades of atrophy, especially of the mucous membrane and the muscularis.

There are often a various number (from one to several hundred) of various sized stones, which lie loose in a large or small amount of thin bile. Gall-bladders, containing stones, and in which infection has taken place, usually contain a thin pus or more rarely a thick creamy pus. The walls of the gall-bladders will often be found thickened and œdematous.

It is therefore apparent from studies of this sort that the various pathological pictures are highly individual. The various conditions found are but stages or progressive steps from simpler processes.

Of especial interest are the changes noted in the liver in some newer studies. In chronic cholecystitis, the liver often presents a picture practically

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identical with that of an early cirrhosis. The inflammation appears to be principally a pericholangitis. The stones which come from and are at times packed in the intra-hepatic ducts, intra-hepatic cholelithiasis, a persisting or recurrent cholelithiasis, are most probably due to a persisting bacterial infection of the ducts or liver parenchyma.

The operative findings were as follows:

A definite thickening or disease of the walls of the gall-bladder, marked adhesions, with attachment to and thickening of neighboring viscera and stones in the biliary tract were found in 70 per cent. of the cases. Enlarged glands around the cystic duct area, thickening of the liver capsule and parenchyma were described many times in the operative notes. Gangrenous or phlegmonous cholecystitis was found in 12 cases.

Induration of the head of the pancreas was noted in 5 cases only. In 75 cases cholecystectomy was performed. In 41 cases drainage was instituted. Choledochostomy was done 6 times. Halstead's procedure (drainage of the common duct through the stump of the cystic duct) was done once. There were no cases reported of cholecyst-gastrostomy or cholecyst-duodenostomy.

In this series, appendectomy was performed 28 times.

It will be of interest to compare the degree and character of the pathology and complications in the cholecystectomy and the drainage series.

Extensive adhesions were encountered in 30 cases of cholecystectomy, while 25 of similar character were found in the much smaller drainage lot. There were 28 stone cases in the cholecystectomies and 14 in the drainage series. Four cases of phlegmonous cholecystitis were found in the cholecystectomies and 8 in the drainage cases.

There were 11 secondary cases, 9 being secondary to drainage procedures, and 2 followed cholecystectomies. The 9 drainage cases had been performed 1 to 10 years previously. The period of relief from the original symptoms ranged from "no relief" whatever in the earliest secondary (re-operated after 6 months) to 9 years. A great increase in adhesions to the surrounding structures was noted uniformly. The gall-bladder walls were thickened. Stones in the gall-bladder imbedded in the walls or blocking the cystic duct were noted in 4 cases of the 11.

Cholecystectomy was done routinely upon this group, except in 1 case. In 1 of the secondary cases, after cholecystectomy, return of symptoms had been present for 1 year (the operation had been done 5 years previously), and the adhesions were very extensive, involving the liver, intestines and biliary ducts. Choledochostomy was performed on this patient.

Another case in the cholecystectomy series, operated on 5 years before, showed pain, jaundice, and vomiting for 2 weeks before the secondary operation, and a report from the patient as having had "poor health" for 6 months before this. Upon opening the abdomen, a biliary cyst was found and drained. The common duct was obstructed by dense adhesions. This patient came to a third operation and the result will be given in the follow-up digest.

The complications met in the cholecystectomy series include a case of perforation of the colon and the duodenum by a very large stone. The upper gall-bladder communicated with the colon, the lower gall-bladder with the duodenum.

Internal hemorrhage from slipping of a ligature necessitated reopening in 1 case, while development of hepatic abscess caused rib resection for drainage in another case. Two cases of malignancy were encountered, 1 of the gall-bladder, the other of the liver encroaching upon the gall-bladder tract.

Literature on abdominal adhesions has been scanty, contradictory and inadequate. The majority of recent writers have considered adhesions from a surgical point of view, usually as the basis of personal opinion, rather than published facts. In such vein, Morris³ in 1896, divides adhesions into 4 groups, in the following order of frequency: (1) the adhesions around the gall-bladder region; (2) adhesions around the cæcum and appendix: (3) adhesions of the sigmoid and (4) pelvic adhesions. Robinson⁴ in the same year reported observations tending to show that the viscera most frequently involved were in their order of frequency as follows: (1) spleen, (2) the mesacolon, (3) the pelvis, (4) the cæcum and appendix, and (5) the gall-bladder region.

Bryant,⁵ in a recent report gives detailed careful observations upon 200 unselected consecutive post-mortem cases, of all ages and sexes. The only cases excluded being those few of recently post-operative origin or those exhibiting recent frank peritonitis. The age of 40 was found to be a critical one for both sexes. There is practically no increase in frequency above the fetal rate of involvement for the different viscera until the age of 40 is reached. Beyond this age there is a sudden increase of about 50 per cent. in the involvement of the different viscera by adhesions. The two actual adhesions or bands found to occur most often in both sexes and at all ages in order of frequency as follows: (1) gall-bladder to the duodenum and to the transverse colon in both sexes; (2) the gall-bladder to the transverse colon in the male and the gall-bladder to the duodenum in the female. In the studies of the male and female fetus, the two adhesions or bands most frequently found were: first, the gall-bladder to the duodenum and to the transverse colon; second, the gall-bladder to the transverse colon alone. It would appear therefore that these two most frequently occurring adhesions or bands are of congenital or developmental origin or due to inflammation during fetal life. The region or quadrants of the abdomen most frequently involved by adhesions or bands in both sexes are, according to Bryant, in the following order of frequency: first, right upper quadrant; second, right lower quadrant; third, left upper quadrant and fourth, left lower quadrant.

In this study, we found that there were four deaths in each series or 8 in all. Two cases in early middle life died from cardio-renal insufficiency after difficult cholecystectomies, 1 including removal of stones and drainage of the common duct.

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Two cases, complicated by bowel perforation, died from shock and peritonitis within 24 hours. This makes the 4 deaths in the 75 cholecystectomies or 5.3 per cent.

In the drainage series the first patient died of peritonitis 10 days after operation for gall-bladder disease, and in which it was necessary to do a resection for gangrenous intestine. The second death was in a case of empyema of the gall-bladder, which was drained 3 weeks after marked sepsis had set in. There was a rise in temperature, pulse rate and respiration and a violent death within 24 hours. The third death was a case showing streptococcus in bile drainage. Death followed from cardio-renal insufficiency. The fourth death came 5 days after first operation. Death 24 hours later was due to cardio-renal complications also.

The mortality percentage of the series was 6.1 per cent.; that of the drainage case 7.2 per cent. Of immediate operative results noted when leaving the hospital 39 were well or apparently cured, .75 were listed as improved, while 8 were unimproved.

A follow-up study 18 months after the discharge from the last patient of the series showed the following:

Eighty of the 130 patients responded in person or answered the questionnaire. Of these the ratio of cholecystectomy cases was 5 to 3 for drainage. Two drainage cases had had but very temporary relief from symptoms; 1 having return of symptoms 5 weeks after discharge, the other 6 months after discharge. Another drainage case was re-admitted re-opened and found to have malignancy of the liver, death following shortly afterward. The secondary cholecystectomy case showing a biliary cyst and extensive adhesions about the common duct was re-admitted to the hospital, and died after a third operation. One cholecystectomy patient, aged 75 at time of operation, was reported as dead in the returned questionnaire, but the cause of death was not given.

All of the remaining 75 patients who responded, exhibited or reported good health and enthusiasm for their operative results.

SUMMARY

SECONDARY CASES—TOTAL 11

Following cholecystectomy—2

CASE I.—Age thirty-three. Gall-bladder removed 5 years ago; recurring symptoms 1 year. Choledochostomy.

CASE II.—Age forty-eight. Cholecystectomy 4 years ago; recurring symptoms 6 months. Biliary cyst drained. Obstructed common duct freed.

Following drainage—9

CASE I.—Age forty-one. Return of symptoms 1 year after operation 10 years ago. Cholecystectomy and freeing of extensive adhesions.

CASE II.—Age forty. Return of symptoms a few weeks after operation. Cholecystectomy with freeing of adhesions.

CASE III.—Age twenty-seven. Return of symptoms 1 year after operation, with stones found at second cholecystectomy.

CASE IV.—Age thirty-five. Adhesions freed at second operation.

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SUMMARY.—*Continued*

Following drainage—9

CASE V.—Age thirty-nine. Previous operation 10 years ago. Cholecystectomy with stones.

CASE VI.—Age forty-three. Stone removed at drainage 5 years ago. Return of symptoms 1 year ago. Cholecystectomy, adhesions freed.

CASE VII.—Age forty. Drainage 3 years ago. Relief for 1 year. Cholecystectomy with adhesions. Drainage 5 years ago, with relief for 6 months. Cholecystectomy with adhesions. Stone in cystic duct.

CASE IX.—Age twenty-nine. Drainage 1 year ago. No relief of symptoms. Cholecystectomy with adhesions.

DEATHS

Cholecystectomy—4

CASE I.—Age thirty-six. Cholecystectomy with extensive adhesions. Died of kidney insufficiency.

CASE II.—Age sixty-two. Cholecystectomy with duodenal perforation. Died of peritonitis.

CASE III.—Age fifty-four. Cholecystectomy with colon and duodenum perforated by large block stone. Upper gall-bladder communicated with colon. The lower gall-bladder with duodenum. Suture of perforations. Death within 24 hours from shock.

CASE IV.—Age forty-three. Cholecystectomy with stone from common duct. Head of pancreas indurated. Death from progressive weakness.

Cholecystostomy—4

CASE I.—Age forty-nine. Cholecystostomy with marked empyema. Violent T. P. R. Duration before operation 3 weeks. Death in 24 hours. Sepsis progressive.

CASE II.—Age fifty-six. Cholecystostomy with stone in cystic duct. Death 5 days after operation. Cardiac death with sepsis.

CASE III.—Age sixty. Cholecystectomy. Bile showed streptococci. W. B. C. 17,000. Cardio-renal death.

CASE IV.—Age fifty-two. One large stone removed at drainage. Drainage tube pulled out 5 days after operation by patient (delirium). Resection of gangrenous gut 10 days after operation. Death followed this within 24 hours from peritonitis.

Percentage of deaths: 6.16 per cent.

Operative results:

Well apparently	39
Improved	75
Unimproved	8

CONCLUSIONS

1. Cholecystitis may have its origin in vague beginnings in early life, but is clearly recognized and routinely treated in or past middle life. The average duration of clear cut symptoms was slightly over 2 years, while the average age of the patient in our series of 130 consecutive cases was 44 years.

2. Widespread, definite and troublesome adhesions with bands from gall-

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bladder to duodenum and transverse colon were the most uniform finding in all types of cases.

3. Seventy-five cases were treated by cholecystectomy, with 4 deaths encountered from this series.

4. Forty-one cases were treated by drainage methods, with 4 deaths. Deaths in both series were due to cardio-renal failure or peritonitis in complicated (stone cases).

5. The mortality percentage was 6.16 per cent. Of 11 secondary cases, 2 followed cholecystectomy, 9 followed drainage procedures.

6. In the follow-up data, the cholecystectomy cases were freer from symptoms and maintained their regained health more constantly.

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BALDWIN AND GILMOUR

SUMMARY.—*Continued*

Following drainage—9

CASE V.—Age thirty-nine. Previous operation 10 years ago. Cholecystectomy with stones.

CASE VI.—Age forty-three. Stone removed at drainage 5 years ago. Return of symptoms 1 year ago. Cholecystectomy, adhesions freed.

CASE VII.—Age forty. Drainage 3 years ago. Relief for 1 year. Cholecystectomy with adhesions. Drainage 5 years ago, with relief for 6 months. Cholecystectomy with adhesions. Stone in cystic duct.

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Percentage of deaths: 6.16 per cent.

Operative results:

Well apparently 39

Improved 75

Unimproved 8

CONCLUSIONS

1. Cholecystitis may have its origin in vague beginnings in early life, but is clearly recognized and routinely treated in or past middle life. The average duration of clear cut symptoms was slightly over 2 years, while the average age of the patient in our series of 130 consecutive cases was 44 years.

2. Widespread, definite and troublesome adhesions with bands from gall-

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bladder to duodenum and transverse colon were the most uniform finding in all types of cases.

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5. The mortality percentage was 6.16 per cent. Of 11 secondary cases, 2 followed cholecystectomy, 9 followed drainage procedures.

6. In the follow-up data, the cholecystectomy cases were freer from symptoms and maintained their regained health more constantly.

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LYMPHO-SARCOMA OF THE SMALL INTESTINES

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LYMPHO-SARCOMA of the gastro-intestinal tract is reported in the literature as being found in every segment from the stomach to the rectum, but seems to show a marked predilection for the ileal division of the small bowel. While of relatively infrequent occurrence as compared with carcinoma throughout the entire intestinal tract, it perhaps is found as frequently in the small bowel as any form of malignancy. Broders and Mahle recently reported twelve cases of lympho-sarcoma of the stomach giving its incidence in comparison with carcinoma as 1 to 68. Their review of the literature showed only one other series as large as their own, with scattering reports of an occasional case from various sources. The literature shows reported cases in the small bowel and colon to be approximately 300; several relatively large series having been collected by various writers, among them those of Libman and Crowther. Krugerz Boaz collected 37 cases of sarcoma of the intestines which were distributed about equally between the large and small bowel; the rectum, however, being the site of a malignancy in 16 cases. DeNoyelles cites the relative frequency of this disease as compared to carcinoma as 1 to 20. The striking similarity in the distribution is noted when it is seen that the rectum and ascending colon, as in carcinoma, are the most frequently involved segments of the large bowel.

Gerster and DeNoyelles report cases in the small bowel occurring high in the jejunum and an occasional case involving the ileum, ileo-cæcal valve and the cæcum. Crowther reports 12 cases occurring in the duodenum in a series of 191 cases, and Libman's review found 15 additional such cases in the same location.

Symptomatology.—Unfortunately this condition is rarely diagnosed prior to operation and its most frequent recognition comes at the autopsy table. There seems to be no single line of symptoms which constantly occurs in these cases. Either the attack is ushered in simulating an acute fulminating abdominal infection, which is usually diagnosed acute appendicitis, or as is more usual the findings of constitutional symptoms of anæmia, cachexia, and weakness predominate. Ochsner describes the early symptoms as indefinite abdominal pain which persists and is not relieved by rest and starvation, as is the case in the usual chronic abdominal infections. The character of the pain is colicky; there is slight if any tendency to localize in any one definite spot. The fact that stenosis of the bowel does not occur until glandular involvement from the outside causes partial intestinal obstruction, militates also against an early diagnosis. Ulceration being rare in the beginning of this disease, whose pathology is located first in the submucous coats of the bowel, precludes

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X-ray assistance being of much value in early diagnosis. The bowel not infrequently is dilated proximal to the tumor because of paralysis of the musculature from direct invasion of the malignancy. The fact that there is a dilatation of the bowel about the growth rather than a stenosis produces an intermittent obstruction which probably accounts for a more constant chain of symptoms than any other one single factor. In the advanced stage of the disease where tumefaction is distinctly evident, obstruction is most likely to occur and a diagnosis of malignancy be made, but without hope from surgical intervention. Cases are reported in which there has been an intussusception present which produced partial obstruction, anorexia, and bloody diarrhoea. In one of our own cases the tumor mass extended into the cæcum through the ileo-cæcal valve and the attempt of the bowel to rid itself of this bolus produced an intussusception with partial obstruction which was diagnosed acute appendicitis with abscess. In the chronic type of case the tumor mass, which is usually irregular and probably most often due to lymphatic involvement in the mesentery, is variable in its location and usually of a not too firm consistency. The latter condition when cachexia has taken place and metastases are evident, must be differentiated from peritoneal tuberculosis, carcinoma, and the granulomata.



FIG. 1.—Case I. Gross specimen; most marked portion of tumefaction is in ileum; cæcal band is distinctly shown.

The age of the individual should have some bearing upon the diagnosis—a sarcoma always being looked upon as a disease of early youth or young adult life. The distribution as far as sex is concerned is about equal. One of our own cases was a young man and the other a middle-aged woman. The age incidence, however, is distributed over the first to the fifth decade. The prognosis is always gloomy; recurrence is rapid despite any treatment available, and Baltzer quotes the duration of the disease as less than one year from its time of onset.

Pathology.—Pathologists agree that lympho-sarcoma of the bowel begins in the lymph follicles and may be either of a primary or secondary nature. The gradual extension of the growth into the mucosa and the other bowel coats, except the peritoneal one, is progressive. This extension rarely causes perforation and resulting peritonitis. The ulceration through the mucous mem-

brane, however, occurs in a relatively high percentage of cases. Occasionally pedunculated growths are found. The microscopic picture is consistent. The type of cell which predominates usually resembles the lymphoid cells of the mucosa, of which there are many variations. In the cases reported by DeNoyelles the predominating cell resembled the transitional mononuclear cell

of the blood. Bunting and Huston show that the lymphocytes in the blood stream migrate into the intestinal mucosa to function normally. Other writers suggest that these lymphoid cells in the presence of some irritation proliferate wildly, and DeNoyelles suggests that a chronic irritation, possibly a specific toxin, played an important part in the genesis of lympho-sarcoma. Because of the histological resemblance to an infectious granulomata he suggests that lympho-sarcoma "Is one of the many bizarre later pictures of lesions which were at one time of the nature of Hodgkin's disease, or lymphoblastic or lymphocytic leukæmia." The lymph-glands which are



FIG. 2.—Case I. Gross specimen opened and showing the protrusion through the ileo-caecal valve into the lumen of the large bowel.

early infected grow rapidly and frequently attain the size of walnuts. Their pressure upon the neighboring loops of bowel occasionally become sufficient to produce obstruction. The invasion of the mucous coats by the tumor itself causes paralysis and distention rather than stenosis.

Treatment.—Treatment by whatever methods undertaken usually yields unsatisfactory results. If the diagnosis be established before too much lymphatic invasion has taken place, surgery seems to offer the best chance of cure or at least the most palliation. Where the process is extensive and where a resection would involve the sacrifice of too wide an area of bowel substance palliative measures such as sidetracking operations are indicated. Radium in certain sarcomatous cases has given such excellent results that some observers have been stimulated to urge its use in this condition. Certainly

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the end results from surgery are poor, even from the standpoint of prolongation of life, to urge it as other than a last resort. Under any of the present day treatments the prognosis is poor, and unless the early diagnosis of this condition can be made there is relatively little chance of instituting other than palliative measures. It is suggested that radiological evidence may be of greater value in an early diagnosis of these lesions under a more improved technic than we have at present. When we know the number of cases of sarcoma of the small bowel reported and consider their uniformly fatal outcome a short time after being discovered, and where an exhaustive study of the clinical syndrome or laboratory investigation have disclosed nothing helpful except the after-thought that X-ray examination might have found the lesion earlier, it is evident that the opaque meal should not be restricted so largely to cases in which carcinoma of the stomach or large bowel is suspected.

The insidiousness of the disease and its lack of a consistent symptom-complex seem to show conclusively that we must look to the röntgenologist for progress in making an earlier diagnosis, if we are to reduce the mortality by any therapeusis now available. Appended are the case reports of two cases which came under our observation and were operated during the same week in 1923.

CASE I.—H. R., male, age thirty-one, laborer. Chief complaint: Pain in right side of abdomen; marked constipation for six weeks. Family history: Negative.

Personal History.—Measles and whooping cough in childhood with complete recovery; pneumonia ten years ago; typhoid fever four years ago, no complications or sequelæ with either. General health good. Otitis media eight years ago, short duration and no recurrence. Frequent toothache. No dyspnœa, œdema or cough. Frequent drenching night sweats, have been common during both winter and summer for many years. Appetite always good; no jaundice; troublesome constipation for six weeks previous to admission. Frequent and urgent urination for last six months. Nervous system negative. Best weight 165; average and weight on entrance 163 pounds.

Present Illness.—Patient felt perfectly well until six months before coming into the hospital. At that time he began having vague abdominal discomforts which he



FIG. 3.—Case II. The gross specimen of the resected small bowel showing where the attachment and perforation took place.

describes as indigestion. Cramping sensations would be frequently experienced after the drinking of cold water or after ingesting a heavy meal. This would be evident sometimes before the meal would be completed. The occurrence of this uneasiness was dependent on the size of the meal rather than upon any particular articles of food. It would be felt most plainly in the lower right quadrant of the abdomen and would persist from thirty minutes to two hours after eating. This phenomenon was noticed about two-thirds of the time. Eructation after eating was common. Small quantities of

food were occasionally regurgitated but no true vomiting occurred. During the five weeks previous to admission a constant, dull pain had been present in the right lower quadrant. This was aggravated by walking or bending over. This condition became progressively more annoying up to the time of admission. Pain and sensitiveness were then so marked over the affected area that the patient was hurried to the hospital at seven o'clock Thanksgiving evening.

Physical Examination.—Temperature 100.5, pulse 105, respiration 24. Well developed and nourished white male thirty-one years old. Mucous membranes gave evidence of moderate anemia. Facial expression anxious. Teeth in poor condition. Tongue lightly coated. Neck, heart, and lungs negative. Abdomen: Distinct fulness in right lower quadrant. No intestinal patterns seen. Rigidity present over lower half of the abdomen, more marked on right. A tender mass was present over the cæcal region with a acute sensitiveness over McBurney's point. This mass was



FIG. 4.—Case II. The specimen cut open showing the inside of the bowel lumen.

ovoid, fluctuant, and felt to be about the size of a grape fruit. Abdomen negative otherwise. Rectal negative.

Laboratory Blood Examination.—Red blood cells 4,000,000, leucocytes 11,000, polymorphonuclears 68 per cent., urine negative.

Diagnosis.—Suppurative appendicitis, localized abscess. Immediate operation advised.

Report of Operation.—Right rectus incision made. Large tumor mass was found involving the terminal ileum and cæcum. Enlarged glands were present in the mesentery in this region. The terminal ileum for a distance of about eight inches, the cæcum and ascending colon were removed, and the terminal portion of remaining ileum was anastomosed end-to-side to the colon. All of the enlarged glands could not be removed. Abdomen was closed without drainage and aside from a wound infection the patient made an uneventful recovery from the operation.

Four months later, the patient returned to the hospital on account of return of abdominal discomfort, dyspnea, and increase in girth of abdomen. Examination of abdomen disclosed masses that were probably the result of continued growth of the neoplastic process.

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Gross Description.—Specimen consists of a portion of ileum, cæcum with attached appendix, and portion of colon. The junction of ileum with colon is distorted and changed from its normal appearance due to an invasion of the wall of the intestines with a tumor mass. The appendix is 140 x 16 mm. adherent to the intestine with a firm, fibrous adhesion. Two centimetres toward colon from origin of appendix, the mucosa contains a fairly smooth, rather firm, elevated tumor mass, about 30 mm. in diameter which tends to circle the colon and extends well into the submucosa. From this mass the wall of the intestine to the appendix

and backward toward ileum, averages 22 mm. in diameter, being infiltrated with a pale gray, fairly firm, somewhat homogeneous tumor mass. About 3 cm. from origin of appendix toward the ileum, the tumor mass extends out into the lumen in a circular manner almost occluding the lumen of the intestine. The wall of the intestine toward the ileum is invaded 12 cm. from origin of appendix from which place the ileum and its mucosa appears normal. The wall of the intestine toward the colon is invaded 5 cm. from

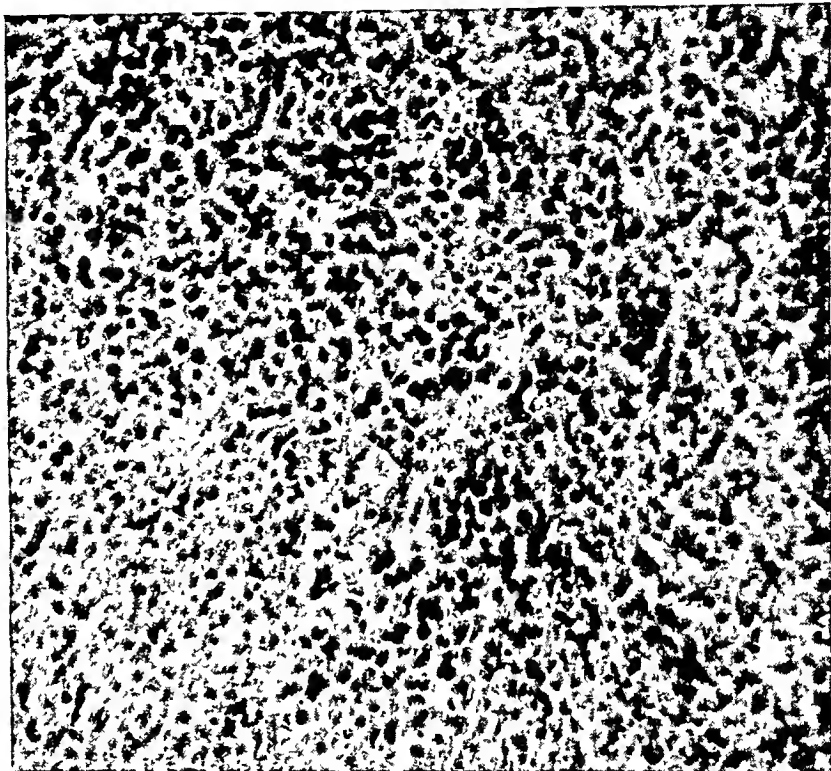


FIG. 5.—Microphotograph from a section of Case I, showing delicate connective-tissue stroma supporting typical lymphoid cells.

appendix from which place mucosa appears normal. The mucosa of the intestine over the area of tumor invasion of its wall (between areas of normal mucosa of ileum and colon) is dull purplish-red, roughened and indistinct as to its normal markings.

(2) Portion of mesentery contains few lymph glands which are fairly firm, dull red and on section varies from pale gray to purplish-red with loss of normal appearance of lymph gland. Cut surface resembles somewhat rice in water with dark shaded colors. The glands average 20 mm. in diameter.

Microscopic Diagnosis.—Lympho-sarcoma.

CASE II.—M. M., age forty-nine, housewife. Patient was a Slav with but slight knowledge of English so that only a scant anamnesis could be obtained. Chief complaint: Pain in lower right side of abdomen. Family history: Negative as far as obtained.

Personal History.—No pulmonary troubles that were at all chronic. Patient was able to do a full day's work up to the time of coming in to the hospital. She had suffered with constipation for the four years preceding. Never jaundiced. Frequency and burning on urinating for six weeks previous to admission. Patient had been pregnant thirteen times, twelve of which terminated normally and one miscarried. The menopause occurred six years before admission.

Present Illness.—Two months before coming into the hospital patient experienced generalized pain in the whole lower abdomen. This persisted for about a week and then became localized in the lower right quadrant. It has been constant there since. Patient has vomited three times during this whole period.

Physical Examination.—Patient is a moderately well nourished white woman forty-nine years old, and is in obvious discomfort. Color is fair. Head, eyes and nose negative. Oral sepsis present. Pharynx and neck negative. Thorax: Antero-posterior diameter increased. Percussion note hyperresonant to 4th rib anteriorly and impaired with limited expansion at both bases. Breath sounds indistinct with occasional moist râles at both bases posteriorly. Heart: Sounds muffled, otherwise negative. Abdomen: Generalized

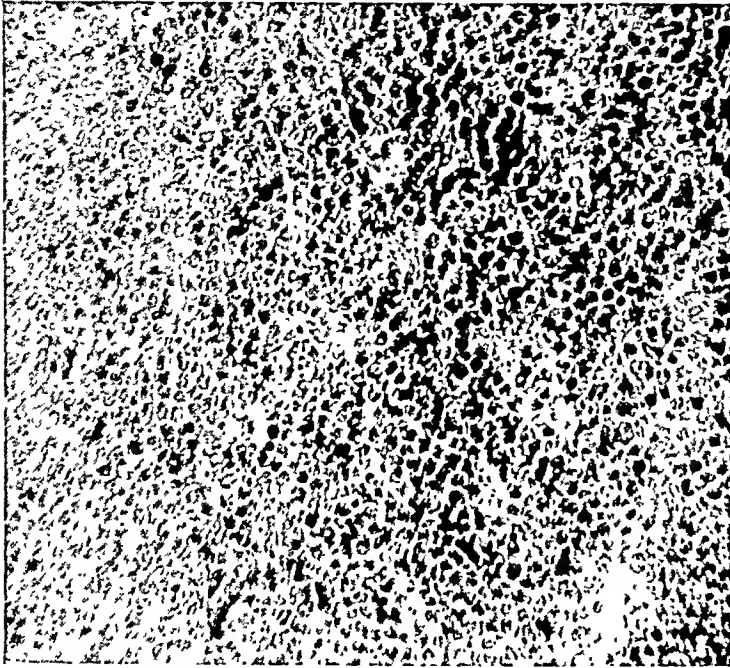


FIG. 6.—Microphotograph of Case II. Picture similar to Case I.

distention. Somewhat tender throughout, most marked in lower right quadrant with a second area of slightly increased sensitiveness in upper part of upper right quadrant. A mass was palpable in right side just below umbilicus and apparently extending into pelvis.

Vaginal Examination.—Outlet relaxed. Yellowish discharge present. Cervix lacerated and pointed up to symphysis. Uterus turned back. There was a smooth mass extending from uterus up into region of cæcum. This was quite adherent and

manipulation brought forth such protests from the patient that thorough examination could not be made at the time. A tentative diagnosis of fibroid tumor with dense adhesions of bowel was made. Under anæsthesia, however, it was found that the pelvic tumor could be moved somewhat without disturbing the position of the uterus to a corresponding extent and appeared to be primary in region of cæcum.

Laboratory Data.—Urine negative. White blood cells 7,200 with 75 per cent. polymorphonuclears.

Diagnosis.—Tumor of cæcum with adhesions to pelvic organs.

Operative Findings.—Right rectus incision made. A tumor of the small gut was found situated about 10 inches from the cæcum, densely adherent in the pelvis and stuck to back of uterus. During delivery from pelvis it was opened at one point. It was resected together with six inches of normal bowel on the proximal side and four inches on the distal side. Numerous hard glands were present in the mesentery. An end-to-end anastomosis was made with catgut and silk. About ten inches proximal to the anastomosis and ileostomy was done after the method of Witzel. No metastases other than glandular were made out. Abdomen closed without drainage. The patient rallied and did well for several days but died on the twelfth day.

Partial autopsy showed no peritonitis. The anastomosis was healed. Numerous lymphatic glands throughout the bowel mesentery were found to be invaded. Death was due to bilateral broncho-pneumonia.

Description of Specimen.—Gross: Specimen consists of portion of small bowel with attached mesentery and lymph-nodes.

(a) Forty millimetres from one end of the gut. The gut wall is enlarged into a tubular mass, incised, 50 mm. in diameter and total length of 140 mm. which is firm,

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yellowish to pinkish-gray and mottled with red. On section, the wall of the tubular mass is 20 mm. thick and is lined with a purplish-red mucosa, wall of which measures 3 mm. in thickness. Mucous surface of normal gut is pinkish-gray, mottled with red. Cut surface shows 18 cm. of gut with apparently normal mucosa, while the remainder shows no evidence of folds in the mucosa, and is rather smooth and pale to deep reddish-gray. The wall of latter portion is 8 to 20 mm. thick, gray, firm and contains a few fibrous striations.

(b) Attached mesenteric lymph-nodes which vary from 6 to 35 x 20 mm. moderately firm. Cut surfaces vary in being gray, yellowish-gray and light brown. All are moderately smooth.

Microscopic Diagnosis.—Lympho-sarcoma.

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URETERO-PYELOGRAPHY

A CRITIQUE ON ITS USE AS A DIAGNOSTIC PROCEDURE

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SOME opposition has arisen as to whether this comparatively recent addition to our diagnostic resources should be more or less routinely employed in the examination of a patient suspected to be suffering from a lesion of the upper urinary tract. It is with the object of replying to these objections that this paper is written.

Is uretero-pyelography a safe procedure? In order to answer this it is necessary to review the history of the method briefly. In 1906, Voelcker and Lichtenberg first suggested the injection of collargol into the renal pelvis through the ureteral catheter with the aid of a syringe. During the next ten years pyelography was employed comparatively seldom because of the reports of the ill effects and even deaths following its injection. A number of other media were next suggested as substitutes, such as argentide, pyelon, etc. These like collargol all belonged to the group of colloids. Selms¹ in 1920 collected 17 deaths following pyelography and this knowledge caused many to abandon the method altogether or to employ substitutes which were not of a colloidal nature like thorium.

Experimental work revealed the fact that some of the deaths following the use of the silver preparations (like collargol) were due to two factors: (a) The use of too much pressure in injecting the solution so that it not only was forced into the renal parenchyma, but by way of the veins of the kidney into the general circulation and caused death² in animals, at least, from pulmonary embolism. (b) The toxic effect of the preparation *per se*. It was found that colloids like silver entered the renal tissues more readily than solutions of crystalline substances and this explained some of the deaths or other ill effects even when but little pressure was used in injecting the solution.

Following the report, however, of deaths after thorium had been injected into the renal pelvis, even this medium was discarded. A new era began with the suggestion that solutions of the halogen salts, such as the iodides and bromides be used as substitutes for the more easily dialysable colloids. It was then found that potassium iodid, even in a relatively weak solution, was too irritating to the renal pelvis and so sodium bromide in 15 to 30 per cent. strength was suggested as a substitute and is still extensively employed abroad.

Although there were less ill effects following the injection of sodium bromide solutions, the intensity of the shadow left much to be wished for. A 12½ per cent. solution of sodium iodid gives just as intense a shadow as the solutions of the potassium salt but has the advantage of being isotonic and hence far less irritable to the mucous membrane of the ureter and renal pelvis. The majority of urologists now employ the sodium iodid in the

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above-mentioned strength. It has the advantage of being non-toxic so that relatively large quantities can be employed without the danger of the toxic effects following the absorption from the renal pelvis of such media as the silver preparations, thorium or even solutions containing any of the potassium salts.

The technic which is most frequently employed is the following:
Preparation of the Patient.—No special preparation aside from that incident to the radiography of the urinary tract is needed. Special stress should be laid upon the necessity of abstaining from the ingestion of food and of much liquid for six hours, at least, before the use of the sodium iodid solution. Even sterile water injected into the renal pelvis of some individuals will cause reflex nausea, vomiting and even symptoms of collapse, and these will be greatly decreased if the alimentary tract is empty.

Injection of the Solution.—Too much emphasis cannot be placed upon the importance of injecting a solution warmed to near body temperature, slowly and with but little pressure. It is not necessary any longer in my opinion to employ the gravity method nor to insert a manometer between the syringe and ureteral catheter. I first aspirate the contents of the renal pelvis and then inject 7 to 10 c.c. of the solution with an ordinary Luer syringe after having introduced a No. 5 or No. 6 ureteral catheter whenever possible as high as the renal pelvis. The best indicator that enough solution has been injected to distend the renal pelvis is the degree of resistance to any further injection. If the patient does not complain of pain and there is no resistance, it is perfectly safe to continue to use more of the solution until there is distinct resistance or one can stop when 50 or 60 c.c. have been injected, to take the first picture and wait until it is developed before injecting any more solution. The first exposure is made while the catheter is inserted either into the renal pelvis or lies at the level of an obstruction in the ureter. The catheter is next withdrawn until it lies near the lower end of the ureter and a second exposure made after injecting enough solution until resistance is again encountered. The third exposure is made about one hour, if possible, after the first one to ascertain whether there is any retention in the renal pelvis or ureter as is so often seen in cases of ureteral stricture. Ordinarily we only make exposures when the patient is in a horizontal position, but if there is any suspicion of a movable kidney, the patient must be raised to the vertical position by elevating the X-ray table at one end before the catheter is withdrawn from the ureter in order that an exposure may be made to determine the degree of mobility of the kidney and a kinking of the ureter. If possible all of the solution should be permitted to escape before the ureteral catheter is withdrawn. I do not hesitate to make a bilateral exposure at the same sitting, provided that the solution is allowed to escape or is aspirated from one side before the second is injected. An unobstructed renal pelvis or ureter empties within a few minutes as one can readily observe if a series of exposures are made at the same sitting. It is always advisable in cases where

there is retention within the renal pelvis to aspirate the turbid urine or more purulent contents before the pyelographic medium is injected.

Uretero-pyelography should never be employed in cases of acute renal infection or where a cystitis is so severe that even ureteral catheterization is a menace. In the latter class much valuable information can be obtained as to the condition of the upper urinary tract by studying the question of ureteral reflux in a cystogram.

That there are ill-effects in some cases following the injection of even the isotonic $12\frac{1}{2}$ per cent. of sodium iodid solution cannot be denied. These, as a rule, are transitory and not alarming. It varies greatly with the individual case. In some, colicky pain, nausea, vomiting and other reflex symptoms are not uncommon, but yield to simpler remedies. Although cases of hæmaturia, at times quite persistent, followed the use of iodid of potassium solutions, I cannot find any report of such sequel after sodium iodid. The only report of a fatal result since the use of the halogen solutions is that of Neergard³ in 1922. A woman of forty-four, who had a latent bilateral pulmonary tuberculosis of many years' standing and a thyroidectomy five years before, was examined as to the origin of a tumor in the right upper quadrant of the abdomen. The indigo carmin excretion from both kidneys was very poor. Fifteen c.c. of a 10 per cent. solution of potassium iodid was injected into the right and 10 c.c. of the same strength into the left renal pelvis. It was allowed to escape through the catheters after the pyelography. Death occurred twenty hours later. The autopsy, including a microscopic and chemical study, failed to reveal the cause of death.

That potassium salts *per se* may act on the heart muscle has been shown experimentally, but it would hardly seem as though this played a part in the above case. As was stated earlier in this paper, the use of potassium iodid is pretty generally abandoned, so that the question of danger from this source can be excluded in the future. The poor condition of Neergard's patient is a warning, however, to study a case thoroughly before pyelography is done as a routine measure.

Reports of cases such as the one of Morton's, where anuria followed bilateral pyelography are not free from the criticism that the ureteral catheterization *per se* might be responsible for the anuria. I have recently seen such a case in consultation, the anuria lasting about 36 hours. Reflex anuria during unilateral ureteral catheterization alone is not rare at all.

Aside from Neergard's case, no other serious ill-effects have been reported following uretero-pyelography since the employment of the halogen salts. With the adoption of a more or less standardized technic of injection and the use of isotonic solutions such as $12\frac{1}{2}$ per cent. sodium iodid, we have entered a new era in the history of this diagnostic method, an era which I feel confident will demonstrate that it is as safe and necessary a procedure as ureteral catheterization or lavage of the renal pelvis, both of which have been epoch-making in the history of urology.

URETERO-PYELOGRAPHY

Is uretero-pyelography a necessary procedure? Those who oppose this method assert that it does not afford information which is not given by other diagnostic methods. In order to answer this it is necessary to take up the principal lesions of the upper urinary and to compare the data yielded by the study of a case before and after uretero-pyelography. I have expressed my views in a recent paper ⁴ in which the importance of uretero-pyelography as an aid to abdominal diagnosis in general was emphasized.

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CONGENITAL PERINEAL TESTICLE

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By CONGENITAL perineal testis is meant an anatomical abnormality which is characterized by the presence of a testis within the boundaries of the male perineum at birth.

On account of the rare occurrence of this anomaly it occurred to the writer that the following case report would be of interest; and that it would be fitting to present therewith a new interpretation of the etiology of ectopic testes.

Case Report.—The patient, a youth eighteen years of age, came to the Cleveland Clinic because of discomfort due to a mass in the perineum. Since birth the right side of the testis sac had been atrophic and unoccupied whereas the left side had been normal in appearance and occupied by a normal testis. Always within the memory of the patient there had been a lump in the right side of the perineum just anterior to the anus. This lump had always been movable to a certain degree. It had been the site of considerable discomfort and on many occasions of actual pain, particularly when sudden pressure had been brought to bear upon it.

Physical examination showed a well developed, well nourished, apparently robust youth with clear skin, 5 feet, 8 inches in height, 140 pounds in weight. The right half of the testis sac was normal in appearance and occupied by a testis of normal size. (Fig. 1, a.) In the perineum, 2.5 cm. in front of the anus and just lateral to the median perineal raphe was an ovoid mass which in size and shape corresponded to the left testis. (Fig. 1, b.) This perineal mass could scarcely be moved posteriorly and its range of freedom from side to side was restricted.

Anteriorly, however, the mass could be pushed up to the corresponding descending ramus of the pubis but could not be manipulated into the subcutaneous inguinal ring. Pressure upon the mass elicited a sensation of pain, which corresponded in character with the pain elicited by the application of similar pressure upon the normally situated left testis. Diagnosis of congenital perineal testis was made.

The operation of orchidopexy was performed by Dr. William E. Lower as follows: Under light nitrous oxid oxygen anæsthesia and local novocaine anæsthesia an incision extending from the subcutaneous abdominal ring to the scrotal neck on the right side was made through the skin and superficial fascia so as to expose the right spermatic cord. With the cord as a guide the fingers were moved backward into the perineum to the testis. An index finger was hooked around the testis and the latter which was only slightly adherent was brought out upon the thigh. Examination of the testis and cord revealed no patent processus vaginalis—in fact the tunica was normal. A bed for the testis was then prepared in the right half of the scrotum by introducing two fingers and stretching the tissues vigorously in all directions. After this was done the testis was picked up and dropped into the bottom of the cavity that had been made for it. There it rested without tension for the spermatic cord was of ample length. No. 1 plain catgut was used for hæmostasis. Closure was made and a supportive dressing applied.

The patient made an uneventful recovery and left the hospital on the eighth day after the operation. He was seen again three months later when the testis was found to be where it had been placed in the bottom of the testis sac and there was no evidence of post-operative atrophy, though the right testis was still slightly smaller than the left as it had been before the operation. (Fig. 1, c.)

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A review of the indices of medical literature relative to this subject warrants the assertion that this anomaly is very uncommon, more uncommon in fact than one is at first inclined to believe. That this is true is obvious because among 92 sporadic case reports of perineal testis many are found to have been of traumatic rather than congenital origin. Coley¹ states that Annondale in 1879 was the first to report the successful surgical treatment of a case of perineal testicle.

Authorities are not in agreement regarding the etiological factors which may influence the production of congenital perineal testis. Heredity has been mentioned as an etiological factor and Godard⁵ speaks of an instance in which perineal ectopia was present in father and son.

FIG. 1.—Case of perineal testicle. A, appearance of scrotum containing left testicle. B, ovoid mass in perineum after orchidopasty. C, post-operative appearance.



In 1786, John Hunter,⁶ in an essay entitled "A Description of the Situation of the Testis in the Fœtus, with its Descent into the Scrotum," makes the following statement: "The testicle in changing its situation does not always preserve a proper course towards the scrotum, there being instances of its taking another direction and descending into the perineum. How this is brought about is difficult to say; it may possibly be occasioned by something unusual in the construction of the scrotum; or more probably, by a peculiarity in the perineum itself; for it is not easy to imagine how a testicle could make its way to the parts about the perineum if these were in a perfectly natural state."

In 1887, Lockwood⁸ studied undescended and maldescended testes and emphasized the etiological importance of the multiplicity of the distal insertions of the gubernaculum testis. He conceived that during the sixth and seventh months of fetal life the fibres of this structure pass through the distal portion of the ventral abdominal wall by way of the inguinal canal and the subcutaneous inguinal ring, thereafter undergoing division to form the several so-called tails. He assumed that one of these tails extended to the pubis at the root of the penis, another to the bottom of the scrotal sac and the third to the perineum ending either by fixation to the tuberosity of the ischium or by intermingling with the fibres of the perineal body. On the basis of this conception, Lockwood believed that the gubernaculum was the factor of chief importance in the phenomena of descent of the testis and that the various types of congenital dislocated testis were due to the excessive development of some one of these gubernacular tails.

This theory that Lockwood advanced so many years ago has served as a simple and unusually popular solution for a problem otherwise unsolved and as such has been widely quoted. In considering the reliability of this theory one is inclined to question whether or not multiple gubernacular tails ever do occur. If we turn for corroborative evidence to the mass of data assembled by investigators in embryology we do not find it, and if we search anatomical monographs for references to multiple gubernacular processes there likewise we fail to find them. Since modern embryological and anatomical treatises do not include any statement regarding the principle upon which Lockwood based his theory, its tenability would seem to be questionable.

In view of the apparent lack of evidence in support of Lockwood's theory, the author desires to offer for the first time a suggestion as to the etiological factors which he believes to be active in the production of ectopia testis, his views being in harmony with modern embryological and anatomical knowledge.

At an early period of embryonic development the mesoderm forms a wedge-shaped plate between the ectoderm and the entoderm on either side of the medullary tube and notochord. The base of this wedge is directed medially and lies adjacent and parallel to the medullary tube. The edge of the mesodermal wedge is its lateral border. Each of these mesodermal plates rapidly differentiates into a medial, an intermediate and a lateral portion by virtue of a longitudinal constriction which appears in its substance close to the thick medial border. The most medial portion is the paraxial mesoderm and the most lateral portion is the lateral plate. Of prime importance in this connection, however,

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is the constricted portion of the mesodermal wedge which lies between the paraxial and the lateral mesoderm. It constitutes what is known as the intermediate cell mass (genonephrostome) and from it are derived the tubules of the three excretory organs in rapid succession and finally the internal organs of the genital system including the testis, epididymus and vas deferens. In the course of development the intermediate cell tract substance finds insufficient space in the retroperitoneum and as soon as it begins to expand it bulges forward invaginating the coelom wall as a fold into the coelom cavity. Because from this fold are derived not only kidney substance but also reproductive gland substance it is called the *urogenital fold*. The urogenital fold begins in the fourth cervical segment and gradually extends toward the caudal end of the body cavity to about the fourth lumbar segment and in the course of its development undergoes a series of important changes. In the first place with the exception of the cranial and caudal ends it becomes divided, throughout its whole extent into a medial *genital fold* and a lateral *mesonephric fold*.

As soon as the reproductive gland (genital fold) is formed it becomes surrounded by a fossa, deep grooves cutting into it laterally and medially. The grooves on either side of the reproductive gland, however, never meet, a portion of the mesoderm persisting between them which gives rise to the stalk of the genital gland known as the mesorchium.

The maximum extension of the anlage of the reproductive gland is from the sixth thoracic to the second sacral segment, that is, over fourteen segments, but eventually it extends over only three or four segments, having degenerated from above downward over from ten to eleven segments. The caudal pole lies as low as or frequently lower than in the adult and accordingly the so-called internal descent of the testes never really exists. The cranial pole does indeed change its position, not, however, because it descends but rather because the upper three-fourths of the gland degenerates. Therefore, what seems to be a descent in reality is a shortening.

At first the urogenital folds are parallel to the vertebral column but as new organs appear between them in the middle line they become displaced. The growing suprarenal bodies force the folds of the opposite sides apart and what is initiated by the suprarenal bodies is continued by the metanephros and the intestinal tract. Caudal to the metanephros the spreading force ceases to act and the urogenital folds are not displaced but the occurrence of displacement above and its absence below produces characteristic bending of the folds. Distally, under normal circumstances the folds of opposite sides fuse in the midline to form the genital cord which is inserted upon the floor of the body cavity.

At about this period before the body wall has become entirely formed by the ventral bending and fusion in the midline there appears upon the lateral surface of the first bend of the mesonephros a knob-like outgrowth, the *inguinal fold* which reaches out in the direction of the rudimentary lateral abdominal wall. The lateral abdominal wall on its part at a point almost exactly opposite in the same horizontal plane, sends out a similar knob-like growth, the *inguinal crest* which is directed medially. The inguinal fold continues to grow in the direction of the inguinal crest and the inguinal crest continues to grow in the direction of the inguinal fold so that eventually the two meet and fuse. Thus, is established a connection which constitutes a bridge between the urogenital fold and the entrance into the inguinal canal. In the interior of the inguinal crest there is from the beginning a cord of compact mesenchyma, the *chorda gubernaculi* which is evident before there is any indication of a differentiation of the abdominal musculature. In transverse section it has a conical shape with its apex directed toward the inguinal fold and with its base almost at the integument. When later the abdominal musculature begins to develop it must grow around the chorda gubernaculi, thus forming the inguinal canal. The union of the gubernaculum with the mesonephric fold is exactly opposite the insertion of the ligamentum testis and in the portion of the mesonephric fold between these two insertions there develops another mesenchymatous cord which connects both with the ligamentum testis and the chorda gubernaculi. On the completion of this union there exists a continuous cord extending from the lower pole of the testis through the inguinal canal and terminating in the integument at the base of the genital tubercle, later the depths of the

serotal sac. The chorda gubernaculi, therefore, is in effect a fibro-muscular cord which marks the path traversed by the testis in its descent from the abdomen. As we have stated, the exact manner in which the chorda gubernaculi exerts its influence has been a subject of dispute. It may be said, however, that its action is passive to a great extent although the active contraction of its smooth muscle constituents no doubt play an important part in bringing the testis first into the internal abdominal ring, then successfully to the testis sac.

The comparatively simple relations which have been described are altered by two processes. In the first instance the anterior body wall is brought from a horizontal to the vertical position and in the second instance the loops of intestine which lie in the exocoelom are taken into the body cavity. It is essential that space be afforded in the coelomic cavity for the intestines and this is accomplished by the enlargement of its sagittal diameter which occurs synchronously with the ventral bending, thus increasing the space between the posterior and the anterior abdominal walls. These changes, however, do not come about without affecting the testis which we last mentioned as lying upon the posterior abdominal wall in the mid-lumbar region attached by a cord, the chorda gubernaculi, to the lateral, later the anterior abdominal wall. When the lateral abdominal wall begins to move forward the sagging in the chorda, if any exists, is taken up until this structure is stretched and taut. The lateral extremity of the chorda is firmly attached to the integument and the medial extremity is likewise firmly attached to the lower pole of the testis. The lateral abdominal wall continues to grow and bend ventrally toward the midline and in event the chorda does not break or pull out its insertions the testis must move from its bed and must of necessity follow the lateral abdominal wall and accordingly become more and more separated from the posterior abdominal wall. The caudal pole of the testis becomes directed ventrally by this pulling force and its long axis changes from a vertical to a horizontal position. Thus, the testis is passively moved in the direction of the internal abdominal ring while at the same time active influence is being exerted to the same end by the smooth muscle constituents of its gubernaculum. In the seventh month the testis wanders down through the inguinal canal (true descent) and the final position of the testis in the testis sac is acquired in the eighth month or at the latest before birth.

At the time of the descent of the testis into the scrotum during the eighth or ninth month of intrauterine fetal life, the structures which make up the ventral abdominal wall and fill the gap between the rami of the pubes are preformed and it is in fact upon the integrity of this preformation that the ultimate success of the testis in its maneuvering from the internal abdominal ring to the serotal sac is dependant. Therefore, a brief discussion of the normal anatomy of the related parts will be attempted, with especial emphasis upon the connections of certain fascial planes.

Toward the lower part of the anterior abdominal wall the panniculus adiposus or superficial fascia which lies just under the skin develops special characteristics. In this locality it consists of two layers instead of one as is its character higher up. There is a fatty superficial stratum called *Camper's fascia* and a deep membranous stratum called *Scarpa's fascia*. The latter directly overlies the aponeurosis of the external oblique muscle. The superficial fatty stratum of Camper passes over the inguinal ligament and is continuous with the fatty superficial fascia on the front of the thigh. The relations of the fascia of Scarpa are very different and a comprehensive knowledge of its distribution is an essential part of the equipment of one who would understand properly the positions available to a testis which has so far succeeded in escaping from the subcutaneous abdominal ring but has thereafter been unable to find its way into the testis sac. If the fascia of Scarpa is followed distally over the abdomen it will be found that in the region of the pubes it passes downward over the spermatic cords, the penis and the scrotum into the perineum where it becomes continuous with the fascia of Colles. On the lateral side of the spermatic cord, that is, lateral to the tubercle of the pubes in the region of the groin, the fascia of Scarpa ends along the line of and immediately distal to the inguinal

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ligament by fusing with the fascia lata of the thigh. The connections of the fascia of Scarpa are of extreme importance and it is desirable that they be fully understood. The practical demonstration of these connections as carried out in the dissecting laboratory are so convincing it has seemed well to include here a brief description of the technic of such a dissection (Fig. 2).

A transverse incision is made through the entire thickness of the superficial fascia on the ventral wall of the abdomen, from the median plane, to the anterior superior spine

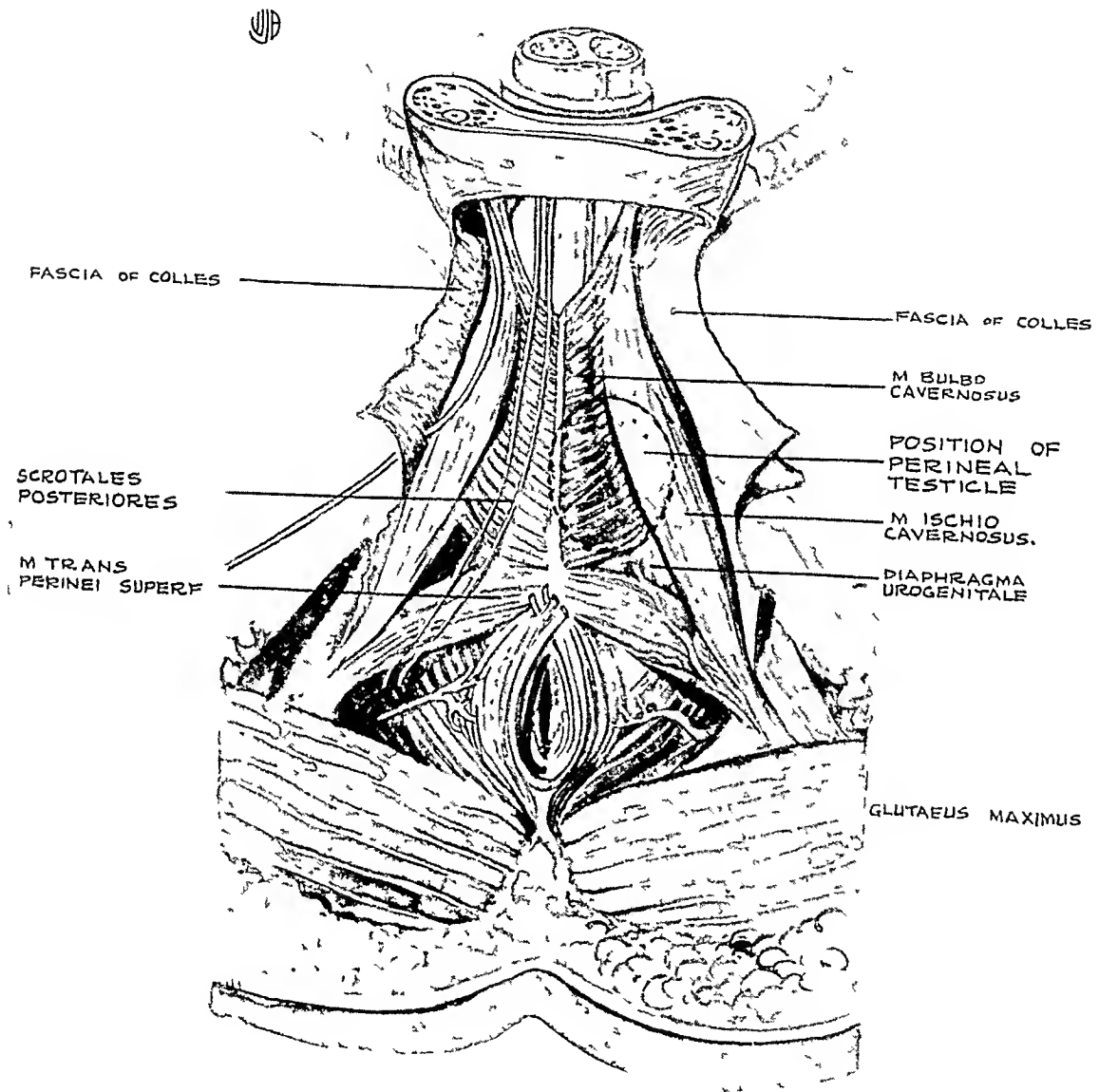


FIG. 2.—Diagrammatic representation of a dissection of the male perineum.

of the ilium. Upon raising the inferior edge of the divided fascia, the two layers of the superficial fascia can be easily distinguished. The fingers can then be insinuated between the fascia of Scarpa and the pearly looking tendon of the external oblique muscle and as they are pushed distally little resistance is encountered since the fascia of Scarpa is bound down to the aponeurosis of the external oblique muscle only by some lax areolar tissue. The fingers can readily be passed as far as the inguinal ligament and no further for there the passage of the hand into the thigh is barred by virtue of the fusion of the fascia of Scarpa with the fascia lata along the line of the inguinal ligament. If now the fingers are carried medially to the region of the pubes and then inclined distally it will be found that they can pass downward behind the fascia of Scarpa and along the spermatic cord into the perineum. No barrier apposes the passage of the hand in this direction and thus the continuity of the fascia of Scarpa and the fascia of Colles will have been demon-

strated. The fascia of Colles is spread over the urogenital diaphragm and has very definite attachments around the limits of that triangle. Thus, laterally it is fixed on either side to the rami of the ischia and pubes while posteriorly it is tucked around the two superficial transverse perineal muscles and blends with the base of the fascia of the urogenital diaphragm (triangular ligament). In this manner a pouch is formed which is of the utmost importance in this discussion. This is the superficial pouch of the perineum and certain important parts are placed within its boundaries, *i.e.*, the superficial muscles of the perineum, the bulb of the urethra, the crura of the penis, the perineal vessels and scrotal nerves, the long perineal branch of the posterior cutaneous nerve of the thigh and the termination of the pudendal artery.

This description of the connections of Scarpa's fascia and of Colles' fascia, of the continuity of one with the other, and of their relations to adjacent structures has a most important bearing upon the unusual positions which ectopic testes are prone to assume.

To digress for a moment, we may add that it also gives a very striking explanation of the course which would be taken by urine escaping from a rupture in the urethra distal to the urogenital diaphragm. The effused fluid flowing along the tissue planes under these circumstances makes its way upward into the scrotum over the penis and along the spermatic cords to the front of the abdomen, filling and distending the potential space between the fascia of Scarpa and the aponeurosis of the external oblique muscle. It cannot gravitate distally to the front of the thigh because there the fascia of Scarpa fuses with the fascia lata along the line of the inguinal ligament.

In an intra-uterine male foetus at the eighth month of development the descent of the testis has so far advanced as to permit it to escape from the subcutaneous inguinal ring. The remainder of the journey which consists of an excursion over the crest of the pubes and into the depths of the testis sac, we have good reason to suppose is the most perilous part of the whole journey, for outside the inguinal ring the testis is deprived of the downward impulse of the contracting abdominal muscles and of the intra-abdominal changes of pressure which aided its passage through the inguinal canal. Here no passive force promotes the continued advance of the testis, but rather the sole responsibility for its progress rests upon the active contractile power of the chorda gubernaculi. In explanation of the occurrence of ectopic testes the writer has conceived that at this dramatic moment the chorda is insufficient and that as a result of the stress its fibres part at some point between its insertions. Should such an accident occur the testis would be left helplessly stranded between the external ring and the scrotal neck and would lie between the fascial planes that have just been discussed. That all such testes remain to be classified subsequently as pubic retentions or that they all shortly find their way into ectopic positions is not the case. Some, no doubt are retracted into the inguinal canal and remain to be classified as undescended testes, while it is possible that others may pass on into the testis sac.

It should be borne in mind that such an unguided testis is subsequently free to move to any point within the fascial planes in which it lies, limited only by the length of its spermatic cord. Mention has been made of the course

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which may be taken by urine after a rupture of the urethra in front of the triangular ligament. One can readily see that a testis which has passed the subcutaneous inguinal ring in event it does not reach its normal place in the scrotal sac may assume any position in the interfascial planes followed by such extravasated urine limited only by the length of its spermatic cord. In other words, the aberrant testis will move along the tissue planes in the line of least resistance. Thus, one can identify the possible ectopic positions that are available to a testis which has lost its guide after it has escaped from the subcutaneous inguinal ring. It may incline proximally insinuating itself between the fascia of Scarpa and the aponeurosis of the external oblique muscle and come to rest in the neighborhood of the ring, in which case the condition is called *interstitial ectopic testis*. In event such a testis is accompanied by a patent processus vaginalis, there may be an associated interstitial hernia of the congenital variety. Such a testis cannot pass distally into the region of the thigh because of the fusion of the fascia of Scarpa with the fascia lata along the line of the inguinal ligament. Such a testis may pass medially to the region of the symphysis pubis and then incline distally, so that it comes to rest upon the dorsal surface of the penis at its base under its fascia, in which case the unusual condition is known as penile ectopic testis. In most cases, however, the testis makes its way over the pubic crest and on encountering some obstacle, such as an atresia at the scrotal neck, slips down over the deep surface of Colles' fascia into the superficial sac of the perineum. Here it finds a resting place among the structures already enumerated as being constituents of that sac. It may not pass beyond the most posterior limit of that sac which is marked by a transverse line drawn between the anterior parts of the ischial tuberosities in front of the anus. Thus, commonly perineal testes occupy a position in the perineum about 2.5 cm. anterior to the anus and just lateral to the median perineal raphé. It is conceivable that such a dislocated testis might be accompanied by a hernia of the congenital perineal type and Coley has reported such a case.

As for the entire group of congenital ectopic testis, there are four classical varieties, which in order of the frequency of their occurrence, are as follows: (1) perineal, (2) interstitial, (3) penile, (4) femoral. The last of these is an entity entirely distinct from the others and is extremely rare. It is commonly understood to be a result of an extremely long mesorchium as a consequence of which the testis instead of being brought up sharply to the internal abdominal ring is permitted to sag away from it to the region of the femoral ring, through which it subsequently herniates distally into the thigh, coming to rest in the femoral triangle in the region of the saphenous opening. Fauntleroy⁴ reports such a case accompanied by a femoral hernia.

Of the three more common ectopias, *i.e.*, perineal, penile and interstitial, it is significant to note that a fascial pocket or sac is a striking part of the picture in the first two varieties and that fact alone causes one to be even more convinced that the aberrant testis did roll around between fascial planes until it accidentally became caught in a pocket.

It is not very uncommon at operation to find ectopic testes fixed at their lower poles to the adjacent tissues and such a fixation has no doubt influenced many to accept the theory of multiple gubernacular tails as being the etiological factor in their production. In the opinion of the writer, however, to interpret such an adhesion as a cause for the ectopic testis, is only another example of confusion between cause, on one hand, and effect, on the other. The primary cause of an ectopic testis is a breaking of the chorda at a crucial moment with the resultant dislocation of the testis. When the unguided testis comes to rest in its ectopic position the proximal end of its fractured chorda makes a new connection with adjacent tissues.

Congenital perineal testis is often accompanied by some abnormality of the corresponding vaginal process of peritoneum. No instance is known in which the vaginal process found its way into the scrotum while its testis went into the perineum. Since under normal conditions the vaginal process precedes the testis into the scrotum, it probably precedes the testis into its aberrant position in these abnormal cases. Ordinarily congenital perineal testes are found to possess the usual tunica vaginalis in a distorted form, but commonly the fusion of that part of the process vaginalis which extends from the abdominal inguinal ring to the tunica is lacking or incomplete, so that in the majority of cases there is a predisposition to inguinal hernia if a congenital hernia does not already exist.

McAdam Eccles,⁸ in his work on the imperfectly descending testis, relates that among 936 instances of imperfect descent of the testis associated with hernia, only five were found to be of the perineal variety.

As for the functional capacity of congenital perineal testes, it may be said that during infancy and preceding the stage of puberty the testes, whatever their positions, have little influence upon the development or the general health of the individual. The converse is true, however, from the period of puberty onward, for at the beginning of this period the testes assume a dual rôle manifested by the formation of spermatozoa within the tubules (external secretion) and by the elaboration of hormones (internal secretion) within the confines of the intertubular interstitial tissue. The function of the former is that of procreation and the function of the latter in harmony with the internal secretory products of other glandular structures is that of participation in the development of secondary sexual characteristics.

The writer has not been able to find any record of a case of congenital perineal testis treated by orchidectomy which has been followed by histological study of the specimen. However, Odiorne and Simmons,⁹ at the Massachusetts General Hospital and others, have studied specimens of undescended testes treated by orchidectomy, and what they found in their cases one might anticipate would be found in any specimen of ectopic testis.

The organs they studied as a rule were flaccid and small. Microscopically the tunica albuginea in each specimen examined was from two to five times the normal thickness.

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It is most interesting to note that the so-called interstitial cells were present in all cases and were uncommonly abundant.

The epithelium of the tortuous seminiferous tubules and the membrane propria upon which they rest were found to deviate markedly from the normal.

In every case the basement membrane was found to be thickened; in some this thickening was slight, and in others so marked as to all but obliterate the lumen of the tubules. In every case also the epithelium itself was markedly abnormal. In those tubules in which a thickened basement membrane had nearly obliterated the lumen, there were no cells or only a few degenerated cells, which were irregular in shape. In other sites the tubules were lined with a single, rarely a double, layer of similar cells of large size, showing no mitoses. These latter cells probably represented supporting cells or the sustentacular cells of Sertoli. Cytogenic or spermatozoa-producing cells were rarely found. Spermatogonia and spermatocytes could be distinguished in some cases, but the processes had rarely gone on to completion and only in exceptional instances were tubules found containing perfectly formed spermatozoa. These changes are no doubt the result of injury and represent progressive chronic inflammatory alterations due to pressure. The cytogenic cells of the testis are highly specialized cells and the sustentacular and interstitial cells are progressively less highly specialized. It is a fundamental pathological rule that the various cell elements of the human organism vary in their power of resistance to injury and regeneration, inversely as the degree to which they are functionally specialized.

By virtue of the protected position and extreme freedom of movement of testes which are normally placed in the scrotal sac, they are rarely subjected to traumatic injury. Congenital perineal testes and ectopic testes generally are not possessed of such freedom of movement. Their positions are more or less fixed and they are subjected not only to the constant pressure of contracting muscles, but also in an exaggerated degree to the possibility of wounds and contusions. They are not immune to epididymitis and vaginal hydrocele, and malignant degeneration may develop.

The diagnosis of congenital perineal testes or of aberrant testes in any of the other usual sites is not commonly attended with any great difficulty. The history reveals the fact that one side of the scrotal sac has been unoccupied since birth and the chief complaint frequently is that of pain, which of a characteristic nature is definitely localized and usually is related to some form of exercise.

Upon physical examination the scrotal sac is found empty and atrophic on one side while the opposite side is occupied by a testis of normal size. In the absence of hernia the inguinal canals are negative. Palpation about the site where pain is complained of reveals a mass beneath the skin and superficial fascia corresponding in shape, consistency and roughly in size to the normal testicle. The possibility that this mass may be a new growth or the product of chronic inflammation must be ruled out. Pressure upon the mass elicits the characteristic testicular pain and it will be found to be more or

less mobile. With ordinary care the vas and constituents of the spermatic cord may often be made out.

The treatment of congenital perineal testis and of the other varieties of aberrant testes is extremely important. The kind of treatment varies according to the age of the subject and the presence or absence of some complicating factor such as hernia, new growth, hydrocele, torsion, the procedure in event of any one of which is only too obvious.

As has previously been stated during infancy and early childhood, irrespective of its position whether undescended or dislocated or normally situated, the testes exert little influence upon the development or general health of the individual, while with the beginning of adolescence the testis ceases to be afunctional. If a testicle is allowed to remain in an aberrant position during the period immediately preceding puberty there is sufficient reason to believe that it will not undergo properly the complete cycle of changes incident to adolescence. If it is allowed to remain in the aberrant position throughout the period of adolescence there is equally good cause to believe that it will remain cytogenically functionless permanently and that therefore the procreative possibilities of such a testis will be almost if not completely lost in most cases. On the other hand, it is believed that the endocrine power of such a testis is not impaired even when it is left permanently in its abnormal position. That this is the case is evident both by clinical observation and by the microscopic findings of Odiorne and Simmons which have been noted above. Therefore, it may be said that the secondary sex characteristics of the possessor of permanently displaced testes are uninfluenced. He is subject to the same desires and motives as the normal individual even though he be a double cryptorchid and sterile.

In view of these facts it becomes evident that measures to correct the position of aberrant testes should be undertaken. They should be brought into the scrotum and it is desirable that this be accomplished at as early a date as is consistent with certain factors which should be considered. Thus, in the absence of some complication it would not be wise to subject a child under ten years of age to the necessary surgical procedure. During infancy and early childhood there is a possibility that such a testis may find its way spontaneously into the scrotum. Such an occurrence is not very uncommon in cases of undescended testes. This is not the case, however, with congenitally dislocated testes. The latter, however, are frequently quite mobile and no doubt much could be done during infancy and early childhood by the exercise of gentle manual traction upon the testis in the direction of the scrotal neck. That such efforts on the part of mother or nurse under the direction of the surgeon might be accompanied by success is not impossible. If the child reaches the age of ten or twelve without the testis having come into the scrotum, an operation should be performed in order that the testis be properly placed in an ample time to permit of the normal prepubertal alterations. It would seem unquestionable that the finer adjustments of functional balance between the cytogenic and the endocrine elements of the testis and between

CONGENITAL PERINEAL TESTICLE

the endocrine elements of the testis and the coördinating endocrine elements elaborated by other hormone-producing glands will best be served by a properly timed operation. After puberty has been established the benefit that may be derived from orchidopexy decreases in direct relation to the length of the period between puberty and the operation.

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BONE REGENERATION FOLLOWING CHRONIC SUPPURATIVE OSTEITIS OF THE DISTAL PHALANX

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IN ORDER to demonstrate the end results in cases of chronic suppurative osteitis of the distal phalanx of the finger, the following investigation was undertaken at the Vanderbilt Clinic. We wished to show: (1) that the degree of bony regeneration following sequestration will vary directly with the amount of healthy bone and periosteum left in place; (2) that in cases in which spontaneous sequestration is allowed to take place, with resulting preservation of periosteum, a well-functioning, slightly phalanx may be expected; (3) that apparently unfavorable early X-ray findings do not necessarily indicate a poor prognosis, and (4) that extreme conservatism in the handling of the infected bone is the method of choice.



FIG. 1.—Case I. Showing loss of major portion of diaphysis.

The process in all cases was that of a chronic osteitis following acute infection of the distal anterior closed space. Treatment consisted in the institution and maintenance of adequate drainage of the closed space followed by removal of the sequestrum only when the latter had completely separated itself from adjoining healthy bone and periosteum. X-ray plates were taken at the time of sequestration, at intervals thereafter, and until, in our opinion, maximum regeneration had taken place.

CASE HISTORIES

CASE I.—J. R. (V. C. 39995F) Age forty years. Anterior closed space infection followed by chronic osteitis of the distal phalanx. Spontaneous sequestration on the nineteenth day following bone involvement. Figure 1 shows separation of practically the entire dia-

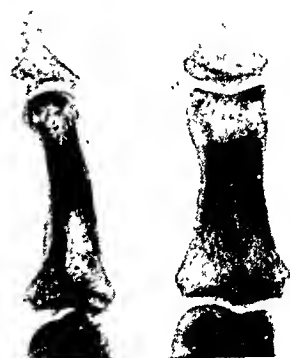


FIG. 2.—Case I. Showing bone regeneration, two months following sequestration.

BONE REGENERATION OF PHALANX

physis. Figure 2 shows amount of regeneration after a period of two months. There was normal joint function and but slight flattening of the tip of the finger.

CASE II.—L. P. (V. C. 67417E) Age twenty-seven years. Infection of the anterior closed space with resulting osteitis of the distal phalanx. Sequestration on the twenty-first day. Figure 3 shows the bare epiphysis remaining. Figure 4, taken one year later, shows practically complete regeneration of the phalanx.

CASE III.—C. H. (V. C. 66425E) Age fifty-five years. In this case there was a similar



FIG. 3.—Case II. Shows loss of practically the entire diaphysis.

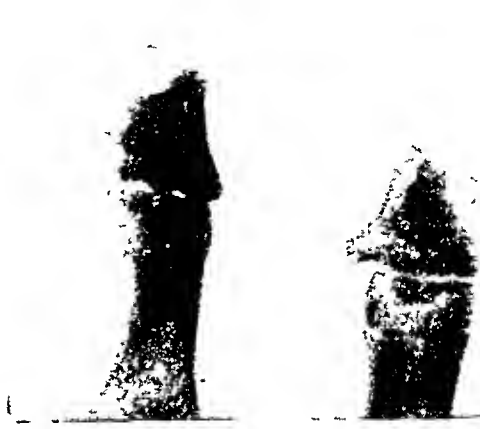


FIG. 4.—Case II. One year later, showing almost complete regeneration.



FIG. 5.—Case III. Shows destruction of distal two-thirds of the phalanx.

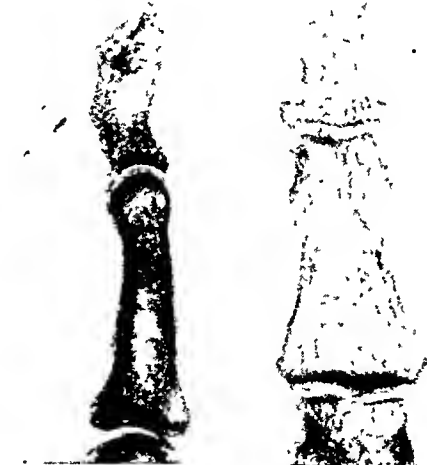


FIG. 6.—Case III. Shows complete regeneration nine months later.

type of infection. Sequestration on the twenty-third day. Figure 5 shows destruction of the distal two-thirds of the phalanx. Figure 6 taken nine months later, shows complete regeneration of bone. The irregularity on the anterior surface in each case evidently represents the point of emergence of the sequestrum.

In the foregoing cases we have demonstrated the results which may be looked for following what we have styled "the conservative treatment" of chronic suppurative osteitis of the distal phalanx. It only remains to caution against certain ill-advised practices, notably "bone scraping," curetting, and even amputation, all too frequently met with in the handling of this condition.

ERRORS IN THE X-RAY DIAGNOSIS OF OSTEOGENIC SARCOMA

REPORT OF TWO CASES WITH AUTOPSY FINDINGS

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THE interest in and better understanding of tumors of bone should be greatly increased by the stimulus of "The Registry of Cases of Sarcoma of Long Bones" instituted by Codman.¹

Accurate data will be obtained and classified for accumulative study in those recorded cases in which pathological material has been obtained at operation or autopsy for histological examination to correlate with the clinical findings, especially those of the X-ray.

That present diagnostic methods are not conclusive is strikingly shown by the approximate 50 per cent. error in diagnosis of supposed sarcomas of bone in the 454 cases submitted for registration.

The value of the X-ray findings in the diagnosis of bone lesions has been overemphasized. The X-ray is undoubtedly the most important single finding, except the histological picture of the pathological tissue itself, but must always be studied in relation to all other clinical data obtainable. The X-ray findings in any group of bone lesions are not specific.

In certain cases of osteogenic sarcoma the X-ray picture is so distinctive as to be accurately diagnostic. In others the X-ray findings may simulate those of pyogenic osteomyelitis so closely that a differential diagnosis between these two conditions is not possible from the plate alone. On the other hand, pyogenic and syphilitic osteomyelitis and carcinomatous metastases to bone may intimately resemble osteogenic sarcoma. The danger, therefore, in attempting to formulate hypotheses concerning treatment of osteogenic sarcoma from cases in which the diagnosis had been based in large measure upon the X-ray picture, should be evident.

Any form of treatment of patients suffering from proven osteogenic sarcoma is notoriously ineffectual. Amputation is still the chosen treatment of most surgeons for osteogenic sarcoma which involves one of the bones of the extremities and when there are no demonstrable metastases. Unfortunately in even the earliest and seemingly most favorable cases for cure by amputation, metastases to lung may have already taken place by the time operation is done, and the patient dies within a few months from the rapid growth of these metastases.

Before amputation is performed in a case of osteogenic sarcoma, X-ray examination should be made of the chest to detect, if possible, the presence of pulmonary involvement. Positive findings will necessarily contra-indicate

¹ Codman: The Registry of Cases of Bone Sarcoma, S. g. O., March, 1922, pp. 335-343.

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amputation of the extremity. Negative findings, however, will not rule out the presence of pulmonary metastases, as the course of the disease following amputation so often shows.

If there is no evidence of metastases and amputation is decided upon, the latter should only be done after the diagnosis of osteogenic sarcoma has been substantiated by incision into the tumor. A constrictor should be placed proximal to the growth before the incision is made. The gross appearance of a malignant tumor of bone is usually unmistakable. It may be impossible to distinguish between a sarcoma, carcinomatous metastasis or an endothelioma, however, from the gross appearance of the exposed tumor. If there is any question in the surgeon's mind regarding the diagnosis on exposing the tumor, a piece of tissue should be removed for microscopical examination.

Of late years the X-ray and radium have been used in an increasing number of cases diagnosed as sarcoma of bone and some very satisfactory results have been reported. In cases which have been considered as cured, one may always question the diagnosis. The primary tumor in a case of undoubted bone sarcoma will sometimes respond to active X-ray therapy in a surprising manner. Experience may show that the results from this form of treatment are better than from the mutilating treatment by amputation.

In those cases in which the clinical diagnosis suggests osteogenic sarcoma and the primary growth is *inoperable* because of its location or local extent, the treatment should be X-ray or radium. In such a case an incision for diagnosis or for the removal of tissue for the microscope is inadvisable as a routine measure because not infrequently following this simple procedure, the tumor will be stimulated to very active local growth, and metastases may develop rapidly. Therefore in these cases which would be inoperable if they should prove to be osteogenic sarcoma, a better procedure is to institute X-ray or radium therapy.

The therapeutic value of this treatment should be apparent in a relatively short time. The growth of the tumor may be retarded or it may even begin to melt away. If nothing is being accomplished by the X-ray or radium, and if the diagnosis of osteogenic sarcoma is questioned, then incision may be made into the diseased tissue to allow of a positive diagnosis.

The following two cases are reported because they emphasize the difficulty which may be had in arriving at a diagnosis in any case of bone disease, because of conflicting evidence obtained in the history, general or local examination or laboratory findings. In each of these two patients the diagnosis was largely arrived at by the X-ray findings, the diagnosis seemed to be substantiated by the reaction of the bone lesion to X-ray therapy and each case came to autopsy for final study.

CASE I.—F. H., age seventeen. Admitted January 12, 1920 to the University Hospital.

Present Illness.—In the winter of 1918 the patient was confined to bed for about a week with the "Flu." In the summer of 1919 he had a mild pleurisy on the left side, became short of breath, felt tired and worn out. Later signs of fluid were found in the left chest and about a quart of straw-colored fluid was removed by needle. Two days

later two quarts of reddish-brown fluid was removed. He had a high fever for six weeks. Weight had been lost before aspiration of the chest, but he began to gain following that. He returned to work in September, 1919, and was feeling fairly well. About November 15, 1919, he began to have soreness in the left shoulder. Movement of the shoulder became painful especially when lifting. Later he noticed some swelling in the shoulder and tenderness on pressure. There has been no grating sensation and no redness. No other joints involved. Has been having some cough and raising some sputum. He is not losing weight or strength. Denies any injury to the shoulder. He was admitted to the University Hospital two months after the shoulder began to pain. *Family History*.—Negative. *Past Medical History*.—Negative.

Examination.—Slightly built boy, with a flushed face. Chest expansion somewhat restricted on the left. Percussion shows some dullness in the lower left axilla. A few crepitant râles are heard in the left apex.

Left Shoulder.—Moderate swelling over the deltoid region and in the axilla. No redness. All movements of the shoulder are markedly restricted because of pain. *Tenderness is very marked* over the upper third of the humerus and in the shoulder joint, so that satisfactory palpation of the humerus is not possible. Superficial veins are enlarged over the shoulder. In the axilla high up one obtains a sense of resistance as if from a growth.

Blood.—Hæmoglobin 88 per cent., white blood cells 9600, Wassermann negative.



FIG. 1.—Case I. X-ray finding of the humerus which led to the diagnosis of osteogenic sarcoma.

X-ray.—Left shoulder region. There is a spindle-shaped swelling of the upper third of the shaft of the humerus involving the lateral aspect especially. This is due to bone proliferation from the periosteum. The cortex and medullary portion of the humerus seems normal. The joint outline is entirely normal. The impression is obtained from the X-ray picture of osteogenic sarcoma of periosteal origin. Von Pirquet reaction is positive.

Aspiration under gas anæsthesia. "Needle introduced into left wall of the chest failed to bring anything, as did the needle introduced into the humerus externally, but a needle introduced into the swelling of the axilla obtained a large amount of blood which led to a diagnosis of sarcoma." Microscopic examination of the clotted blood was negative for tumor cells.

Course.—During the first week of entrance the patient had a fever ranging between 101–103 and a pulse of 110 average. He was treated intensively by Dr. Bundy Allen with the X-ray and was given increasing doses of Coley's toxin. He had a febrile reaction with the injections but the general febrile course was progressively downward so that it ranged

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around 99–100. Was discharged March 13, 1920 with the following note: "Motion in the shoulder was definitely improved by X-ray treatments and use of Coley's toxin. There was also marked decrease in the amount of pain. Slight noticeable decrease occurred in the size of the mass in the axilla."

During the following year he was given three more courses of X-ray treatment, the first of these being accompanied by injections of Coley's toxins. At each admittance the boy showed marked improvement in every way. The fever was gone after the first course of X-ray and Coley's toxins, he increased in weight and strength and he felt well. The swelling in the shoulder region and axilla began to decrease in size and the range of motion increased progressively. At the end of nine months the shoulder was of the same size as the opposite and the pain and tenderness were gone. There was still an indefinite sense of resistance high up in the axilla. X-ray pictures of the humerus showed no evidence of bone pathology whatever.

Seventeen months following his initial entrance to the hospital he began to cough and have night sweats. He began to have a fever as high as 102° every afternoon. The shoulder continued to improve. Examination showed slight lagging of the left chest and crepitant râles could be heard over it. X-ray plates of the chest showed both lungs to be extensively mottled by gross shadows and a diagnosis of sarcomatous metastases to the lungs was made.

The cough continued, dry and hacking in character. One

morning after a severe paroxysm a cupfull of blood was raised. A moderate number of acid fast bacilli were found in smears of the sputum. This finding was made again two days later. It was felt that the metastatic process in the lung had lighted up a latent tuberculous focus. The patient soon began to lose ground rapidly and died in December, 1922, two years after the onset of the symptoms referable to the shoulder for which he had entered the hospital. A partial autopsy was allowed in the patient's home.

Autopsy Findings.—An incision was made over the upper end of the left humerus and carried onto the chest wall to the sternum and over the latter, downward to the xiphoid. The upper one-half of the humerus, the shoulder joint and the axilla were exposed.

There was a moderate amount of fibrous connective tissue in the axilla and the muscles of the arm and around the joint seemed somewhat atrophic. The humerus showed no evidence of tumor or infection. It appeared perfectly normal in every way. The shoulder joint was intact. There was no evidence of any joint lesion. No tumor mass, nor enlarged lymph-nodes were found in the axilla.



FIG. 2.—Case I. After one year of X-ray therapy and Coley's toxins, all active symptoms were gone.

Both pleural cavities were obliterated by adhesions. Both lungs were extensively involved by areas of consolidation. In some of these areas, caseation had taken place and in others, cavities the size of walnuts were present. The gross picture was that of extensive progressive pulmonary tuberculosis. No areas suggestive of tumor metastases were found. No further examination of the body was permitted.

Histological examination of the bone showed no evidence of any pathological process whatever. Sections of the lung demonstrated the lesions of tuberculosis only. No evidence was found of tumor.

Discussion.—The history and physical findings in the chest were strongly suggestive of pulmonary tuberculosis and the condition in the shoulder at first was felt to be a tuberculous arthritis.

The local physical findings could be those of either tuberculosis of the joint or sarcoma of the humerus, although the indefinite mass high in the axilla which gave only blood on aspiration pointed strongly to sarcoma.

The X-rays showed no pathology in the joint, but a proliferative lesion of the upper end of the humerus involving the periosteum. The picture was strikingly that of an osteogenic sarcoma.

The reaction of the lesion to X-ray therapy was spectacular. No form of immobilization was used. The symptoms of intolerable pain and severe tenderness began to show early relief, the swelling subsided, the fever fell and X-ray pictures of the humerus demonstrated that the periosteal new bone was melting away.

The development of gross changes in the lung suggesting metastases seemed to clinch the diagnosis of osteogenic sarcoma. The later finding of tubercle bacilli in the sputum was disturbing, however.

FIG. 3 —Case I. X-ray of the humerus removed at autopsy.

It is impossible to state in the light of the autopsy findings, just what the bone pathology was which produced the marked symptoms. There may have been an osteogenic sarcoma of the humerus which went on to a two-year cure under X-ray therapy aided by Coley's toxins. It is more likely that the lesion was an unusual one of tuberculosis, stimulating the periosteum to bone production.

If this patient had not died and an autopsy been held, this would have been considered an undoubted case of osteogenic sarcoma cured by X-ray therapy.

CASE II.—D. N., age fourteen. Admitted March 8, 1920 to the University Hospital.

Present Illness.—Patient was last perfectly well in September, 1919. During this month she felt dumpish and her legs ached when she sat down. Appetite poor. In November, her first menstrual period occurred, but this caused no change in the symptoms.

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In December, she sat down hard upon the ice and the small of the back was sore between the hips. In January, patient developed constant pain in the left thigh anteriorly and in the left knee. The knee was swollen and it hurt the patient to move the leg. She was in bed a week, and was then able to get up a little for two weeks. Sharp shooting pains developed in the left groin; she went to bed and has stayed there ever since. Slight movement of the lower extremity causes severe pain relative to the groin and knee; also complains of a knot in the ankle. The thigh is very tender to the touch but has never been discolored and she thinks has never been swollen. It feels hot. She has no pain if she lies perfectly quiet. Has lost much weight and one-half of her strength. Has had chiropractic and osteopathic treatments without relief. Enters the hospital two months following the onset of symptoms.

Past Medical History

—Respiratory system.

Does not catch cold easily nor have a chronic cough. Raises no sputum and never coughed up blood. Genito-urinary system: Admits some trouble in starting and stopping the stream recently, otherwise the history is negative.

Family History.

—One paternal aunt had a tuberculous kidney removed. Absolutely negative otherwise.

Social History.

—Menses began four months ago, has had two periods since. Admits of some leucorrhœa

Examination.

—The patient is an undernourished girl who is extremely fearful of being examined because of pain in the left lower extremity.

Lungs.—There is a higher pitched percussion note over the left apex in front. The breath sounds are harsh over this area. Subcrepitant râles are heard over the left clavicle.

Abdomen—There is diffuse tenderness over the lower half of the abdomen.

Extremities.—The left limb is held everted, abducted and flexed. The leg is flexed on the thigh. There is marked pain on movement referred to the hip. The entire left extremity seems larger than the right. There is marked bony tenderness throughout the left thigh. Palpation causes marked tenderness over both hip joint and knee. There is definite thickening or induration in the region of the hip joint. The joint fluid in the knee seems a little increased but the bones do not seem enlarged. There is no pitting on pressure over the shin

The lymph glands are nowhere enlarged.

Blood—Wassermann negative. Hæmoglobin 100 per cent. Leucocytes 16,032.



FIG 4—Case II X-ray evidence which largely contributed to the diagnosis of osteogenic sarcoma.

Differential count: Polymorphonuclears 70 per cent., lymphocytes 29 per cent., transitionals 1 per cent.

X-ray.—The X-ray of the hip reveals a marked picture of osteoporosis.

The upper end of the femur seems separate from the neck. The great trochanter is absorbed and the lesser trochanter barely visible. The upper end of the shaft is moth eaten and there is no outline of the capsule of the joint. There is no bony overgrowth.

Aspiration of the region of the left hip in various places under gas anæsthesia obtained no blood, fluid nor material of any sort.

Urine.—Albumen was found on occasions, but no casts. Red cells were present on two examinations Bence-Jones bodies were present. An acid fast organism was found

in one uncatheterized specimen, but none in urine drawn from bladder, and guinea-pig inoculation of the urine was negative for tuberculosis.

Fever.—On the second day following admittance the patient had a fever of 101° . Following this the temperature stayed around normal with occasional rise to 99° – 100° .

Course.—X-ray treatments were begun by Dr. Bundy Allen March 13, and carried out intensively through March, April, May, July, October and December.

The patient improved definitely as far as the local and general conditions were concerned as shown by symptoms and X-ray pictures.

FIG 5.—Case II. After six months of X-ray therapy. Note the marked increase in density of the bone and the filling in of the eroded areas. The patient was practically free from any active symptoms at this time.

The pain began to subside with the beginning of X-ray therapy and in three weeks the patient could be turned in bed or moved onto a cart to be taken to the X-ray room with very little discomfort. The tenderness became markedly less. This general improvement was progressive.

At the end of a month, X-ray plates seemed to show an increased density of the pathological bone and a decrease in the amount of destruction. This also was a progressive improvement.

The local and general improvement became such that pain and tenderness in the region of the hip became completely absent after six months. Some induration persisted, and there was very little if any movement in the hip joint. The patient was up daily in a wheel chair.



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About December 21 an ulcer through the skin developed over the groin, and increased in size. It was considered to be an X-ray burn. January 4, 1921 a violent hemorrhage took place through this ulcer and the patient died within a half hour.

Autopsy by Doctor Armstrong.—On the left groin was an ulcerated area roughly circular in shape and about 6 or 7 cms. in diameter. The ulcer was necrotic. The borders were ragged and necrotic but not undermined or terraced. In the floor of the ulcer and exposed by it was the femoral ring and the femoral sheath. The sheath and the walls of the blood-vessels were soft and easily torn.

The body was opened by the usual midline incision. The heart and pericardium showed no pathological change of note. The left pleural cavity was free from fluid but contained a few firm adhesions about the apex and the posterior surface. The left lung was without other notable pathological changes. The right pleural cavity was free from fluid and exudate but there were many firm adhesions on the posterior surface. In the upper lobe was an area about 4 cms. in diameter which had the appearance of a partially healed tuberculosis. The mediastinal glands were large and some of them caseated.

The abdominal organs were without gross pathological changes of interest. There was no free fluid, no adhesions and no enlarged glands. The kidneys were normal in size and position. The capsule stripped readily and the cortex of the kidneys appeared normal.

A deep incision was made from the anterior superior spine of the ileum downward along the external surface of the thigh for a distance of 25 cms. As the incision was made a large amount of thick creamy pus escaped. It was this pus that burrowed down between the muscle sheath of the anterior and lateral muscles of the thigh to within a few centimetres of the knee. Within the muscle sheaths were found many small abscesses and burrowing sinuses filled with this thick creamy material. The head of the femur was broken off with the fingers, being honey-combed and soft, transparent, jelly-like substance. The head, neck and upper portion of the femur was so soft and honey-combed that it was easily broken. There was grossly no suggestion of neoplastic growth.

Microscopically.—Sections from the upper lobe of the lung showed the characteristic lesions of tuberculosis. The mediastinal glands were also tuberculous. A tubercle was found to involve the capsule of the spleen. The kidneys showed no pathology.

The bone presented a large amount of old granulation tissue infiltrated with lymphocytes, plasma cells and polymorphonuclear leucocytes. One section shows small pieces of necrotic bone lying in the centre of miliary abscesses. Around these pieces of necrotic bone there are masses of cocci. There is no evidence of tuberculosis in any of these sections. No evidence of tumor is found.

Discussion.—Differential diagnosis had to be made in this case between tuberculous osteomyelitis of the femur, pyogenic osteomyelitis and osteogenic sarcoma.

The positive lung findings, the presence of acid-fast bacilli in the urine, although this was not substantiated in catheterized specimens, and the history of tuberculosis in an aunt, suggested strongly tuberculosis. The local condition was also strongly suggestive of tuberculosis in the history of its onset and the physical findings. The relatively afebrile course spoke against an active tuberculous joint condition. The X-ray picture was not characteristic of a tuberculous hip disease, because of the extent of the pathological process involving particularly the bone from the head to the shaft, the latter in the region of the trochanters being markedly disintegrated.

A subacute pyogenic infection of the femur had to be considered principally because of the X-ray findings. However, in spite of the local evidence

of an active destructive process of the bone of considerable extent, no abscess in the soft tissues could be made out and pus was not found by aspiration. Also, the absence of a sustained febrile reaction pointed against an active pyogenic infection, although there was a leucocytosis of over 16,000. The striking symptomatic and pathological response to X-ray therapy was not to be expected of a pyogenic bone infection.

An osteogenic sarcoma was the presumptive diagnosis and was made in large measure by exclusion. This diagnosis seemed to be confirmed by the early relief obtained from X-ray therapy. No other form of treatment was used. The severe pain on movement and the very marked tenderness began to disappear within a few weeks until the girl was changed from a patient who was fearful and fretful into one who was bright and happy and able to wheel herself in comfort around the ward. The swelling and induration in the region of the hip subsided and the X-ray seemed to demonstrate a beginning healing of the pathological process in the bone.

The autopsy revealed no gross nor microscopic evidence of neoplasm. An area of pulmonary tuberculosis was found but the bone involvement was not tuberculous. The post-mortem findings were those of a pyogenic osteomyelitis of the femur. It is possible that the pyogenic infection of the bone took place from without through the X-ray ulcer which developed two weeks before death, and was superimposed upon some other pathological process which was healed through the action of X-ray therapy. The most likely explanation is that the original bone involvement was a low-grade pyogenic osteomyelitis, hæmatogenous in origin, which began to subside about the time the patient entered the hospital. In all probability the X-ray therapy had little or nothing to do with the improvement of this patient. We have seen no positive benefit from the use of X-ray in other proven cases of pyogenic osteomyelitis.

If this patient had gone on to complete recovery, or if an autopsy had not been obtained, the positive diagnosis of osteogenic sarcoma would have been apparently established and the X-ray would have been credited with a therapeutic result which would be unwarranted in relation to osteogenic sarcoma.

SACRAL NERVE BLOCK ANÆSTHESIA

THE ANATOMY INVOLVED, TECHNIC, AND CLINICAL APPLICATION

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NERVE blocking is rapidly becoming a valuable adjunct to the expert surgeon. It is now generally recognized that local or regional anæsthesia not only may be a life-saving measure in the surgical treatment of old and debilitated patients, but that it is a method that may be successfully employed routinely in a number of major surgical operations. It not only may reduce the mortality in emergency operations, but it lowers the morbidity in the general routine of surgical procedures. Local anæsthesia, however, is not of like value for surgical work in all regions of the body. Its value depends on the limitation of the operative field and the ease of access to the nerve trunk supplying this field. In operations involving the pelvic floor and viscera the operative field is definitely limited by the bony pelvic girdle, an area entirely supplied by sacral nerves. Consequently blocking of the sacral nerves within the sacrum is an easy and efficient means of producing local anæsthesia. In the opinion of surgeons who have had the most experience with the method, it has only to become better known to be more extensively employed.

Notwithstanding the fact that the popularity of sacral nerve block anæsthesia in operations on the pelvic floor and viscera has increased considerably during recent years, marked differences of opinion still exist as to the limitations and efficiency of the method. This is well illustrated by the remarks in Oxford Surgery of two eminent American authorities. In the section on local anæsthesia, Harris asserts that blocking of the sacral nerves by an intrasacral injection is one of the most satisfactory procedures in the field of local anæsthesia. In the section on spinal anæsthesia, Babcock asserts that sacral anæsthesia (also called epidural, extradural and caudal anæsthesia) is efficient in only 55 per cent. of cases, and that it has such limitations that only very devoted enthusiasts will have the patience to continue its use. Braun has never favored the method. In the fifth edition of his text-book (1919) he foregoes any discussion of the method because "spinal and sacral anæsthesia are opposed to local anæsthesia." In his sixth edition the method is discussed in the chapter on spinal anæsthesia with but very little enthusiasm.

It is difficult to understand why eminent authorities on local anæsthesia should classify sacral nerve block with spinal anæsthesia. Whether sacral nerves are blocked by the parasacral, the single epidural-injection, or the transsacral method, the procedure is essentially different from spinal anæsthesia and should not be confused with it. The nerves in the sacral canal

are identical with nerve trunks in other parts of the body, and in reaching them with anæsthetic solutions within the sacral canal, and at their exits through the sacral foramina, they are affected the same as other nerve trunks would be by paraneural injections. In spinal anæsthesia the injection is made into the dural sac, confined within it at all times, and distributed by the spinal fluid. In sacral nerve block by the single epidural injection, the fluid may ascend the vertebral canal in the extradural space when a large amount is injected, and it also escapes through the sacral foramina in all directions, but with proper technic it never penetrates the dura to mingle with the spinal fluid. Sacral nerve block by the transsacral, or by the single epidural-injection method, should therefore be no more confused with spinal anæsthesia than block of these nerves by the parasacral method, which is credited to Braun.

The efficiency of sacral nerve block anæsthesia by the epidural-injection method varies greatly in the hands of different operators. The highest incidence of failures, 45 per cent., is recorded by Babcock, although he reports no series of cases. Pickens reports seventeen failures in 100 cases. The best results were obtained by one of us (Scholl), who in a series of 400 urologic cases had only twenty-seven failures (6.7 per cent.). The incidence of failures may be further reduced by proper combination with the transsacral method described later. Meeker and Frazer, in a series of 225 operations on the pelvic floor and viscera at the Mayo Clinic, report only three failures by the combined method.

To obtain perfect anæsthesia constantly by block of the sacral nerves, as by block of other nerve trunks, one must have a thorough knowledge of the anatomy of the region. This is much more important in regional than in infiltration anæsthesia, and involves not only descriptive, but topographic or perspective anatomy. To block nerves successfully one must not only know their distribution, but be able to visualize the course of their trunks in relation to surrounding structures, especially to the bony prominences of the skeleton, which are the most reliable landmarks on the living subject. It requires practice in passing the needle into the sacral canal and foramina, always to deposit the solution next to the nerve trunks; when anæsthesia does not result, it is because the solution has not been accurately placed.

Early in our experience with sacral nerve block anæsthesia, we became interested in the topographic anatomy of the sacral region, particularly that of the posterior aspect of the bony pelvis. A perusal of the literature on this subject emphasizes the frequency of variation in structure of the sacrum. This variation is impressed more forcibly by a comparative study of sacra from the adult skeleton. We have recently studied 100 such sacra from the anatomic laboratories of the University of Chicago, Loyola University, and Hahnemann Medical College of Chicago, observing anatomic anomalies and taking accurate measurements of each sacrum.* Valuable information

* The authors wish to express their thanks to Dr. R. R. Bensley, of the University of Chicago, Dr. R. M. Strong, of Loyola University, and Dr. W. B. Smith of Hahnemann Medical College, for affording them the use of the osteologic collections.

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has thus been obtained as to the influence of these structural variations and malformations on the technic of blocking sacral nerves.

The Normal Sacrum.—As regards block of sacral nerves the most important anatomic features of the sacrum are the canal, its contents and the topography of the posterior aspect of the sacrum (Fig. 1). The sacral canal is a continuation of the spinal canal and is enclosed by the bony walls of the

sacrum, except at its lower end where it terminates in the hiatus sacralis. The canal in cross-section has the shape of an isosceles triangle above, with base anteriorly, average dimensions being 31 mm. for the base, and 16 mm. for the altitude. The canal becomes smaller below as the forward curvature of the sacrum is followed. It contains the dural sac, which usually ends at the lower border of the second sacral segment, usually about 6 cm. from the sacral hiatus. Thompson, in an examination of thirty-three cadavers, found the average distance to be 5.8 cm., the shortest 4 cm., and the longest 7 cm.

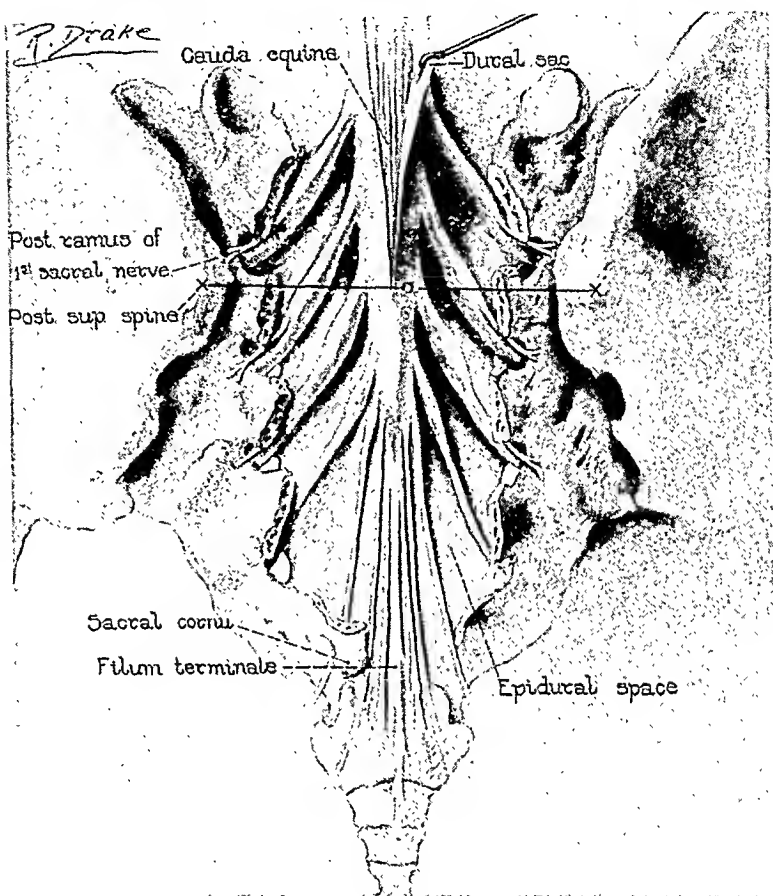


FIG. 1.—Anatomy of the epidural space. Sacral laminae have been entirely removed. The fatty areolar tissue and lymphatic and venous plexuses normally filling up this space have also been removed, leaving the dura and nerve trunks in position. Note the relation of the interspinous line *a*, to the first and second sacral foramina.

Within the dural sac the nerves of the cauda equina are bathed in spinal fluid. As each pair of nerve roots of the cauda equina passes outward, the nerves lie free for a variable distance in tubular prolongations of the dura before the latter blends with, and contributes to, the thickness of their sheaths. The nerves here lie against the anterior wall of the sacrum and when they reach the lateral foramina the contribution of the dura to the perineural sheath is no longer evident.

Within the sacrum the dura is not attached to the periosteum as in some other localities, except by a downward continuation, the filum terminale at the lower end of the sacrum. The space between the dura and the periosteal lining of the canal is called the epidural cavity (cavum epidurale) and is filled with delicate, fat, areolar connective tissue, lymphatics and venous plexuses.

The lower end of the sacrum presents a triangular opening on its posterior aspect, the hiatus sacralis giving entrance to the sacral canal. The extremities

of the base of this triangle are marked by the two sacral cornua, which represent an undeveloped fifth spinous process. The apex of this triangle is designated by the termination of the sacral crest (*crista sacralis*). Usually the fourth pair of arches have not united at this point, but the posterior bony wall is continuous between them (Fig. 2, e). The average distance between sacral cornua is 13 mm., the height of the hiatus 22 mm., and the distance between anterior and posterior walls at the apex of the triangle 4.5 mm. The hiatus is covered over by a dense ligamentous structure, the posterior sacrococcygeal ligament, or obturator membrane.

The four lateral sacral foramina lie between sacral segments and give passage to the upper four pairs of sacral nerves. The fifth sacral nerve passes through the sacral hiatus laterally below the sacral cornu and lies in the sacral notch below the fifth segment. These foramina lie in the same straight line on either side of the sacral crest, are oval or circular in shape, and covered over by ligamentous structures. They traverse the sacrum anteroposteriorly and almost perpendicularly to the tangent of the sacrum. They are very nearly equidistant from each other, the distance decreasing from above downward. The average distance from S-1 to S-2 is 17 mm.; from S-2 to S-3, 14 mm.; from S-3 to S-4, 14 mm., and from S-4 to the sacral notch at the lower margin of the sacrum, 13 mm. The average longitudinal diameter of the first, second, third and fourth sacral foramina are 26, 19, 12 and 7 mm., respectively.

Variations in Structure.—Variations in structure which are of significance in the technic of sacral nerve block are those involving (1) the amount of closure of the sacral arches to form the sacral crest, (2) the number of sacral vertebræ, (3) the number and size of foramina, (4) the curvature of the sacrum, and (5) traumatic and pathologic deformities, or asymmetric sacrums.

The size of the sacral hiatus varies greatly, according to the degree of closure of the posterior arches of the sacral segments during the developmental period (Fig. 2). In our series of sacrums it was large enough in all cases to permit the passage of a small spinal puncture needle, although in two or three instances it would have been exceedingly difficult in the living subject because of anteroposterior flattening. The hiatus may occasionally be reduced in size by osseous bars passing from sacral to coccygeal cornua, in cases of partial ossification of sacrum and coccyx. The cornua in such instances, however, are distinctly palpable.

Operators have also ascribed failure to enter the sacral canal to the presence of an ossified sacrococcygeal ligament, thus entirely closing the sacral hiatus. We have found no evidence of osseous changes in this membrane in sacrums and are inclined to explain a large percentage of such failures on the basis of improper technic.

The laminae of the last sacral segment never join, and those of the fourth often do not. In sixteen instances the hiatus extended up to the third spine, in eight up to the second, and in one to the first, while in one there was an

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entire deficiency of the roof of the sacral canal, or complete sacra bifida (Fig. 2). Wheeler, in the examination of 1000 röntgenograms of the sacral area, found eight complete sacral bifida.

Deficiency in the roof of the sacrum above the sacral hiatus is rare. It occurred between the first and second segments in three instances, between

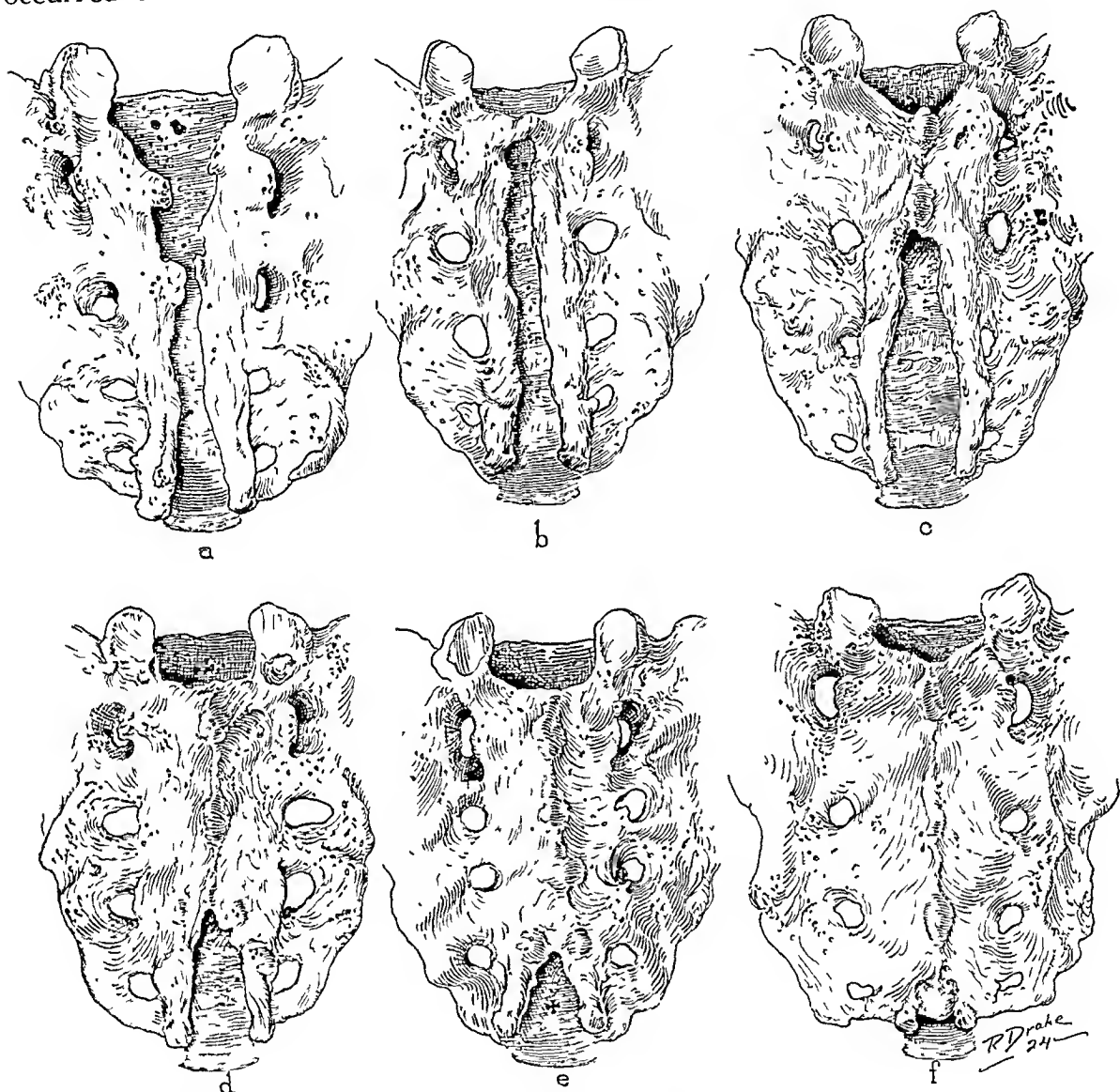


FIG. 2.—Specimens illustrating the variable amount of closure of the sacral arches to form the sacral canal and sacral hiatus. *a*, complete sacral bifida, the canal being open throughout its entire extent. *b*, closure of the first arch only. *c*, closure of the first two arches. *d*, closure of the first two arches, the bony wall extending down to the third arch, spines of which have not united. *e*, the normal condition. The first three arches are formed, the bony posterior wall extending down to the fourth arch, spines of which have not united. The cross marks the site of puncture for the caudal injection. *f*, abnormally low closure and small hiatus. A definite overhanging fourth spine is present.

the second and third segments, and between the third and the fourth in one instance each (Fig. 3).

There is frequent variation in the number of vertebræ composing the sacrum; not infrequently there are six, a condition more often due to inclusion of the first coccygeal than of the last lumbar vertebra. Vesalius depicts the sacrum as consisting of six pieces. In our series, sacra of six segments were found in 19 per cent. of the cases. In a collected series of 2476 sacra, Frets found them in 20.76 per cent. of the cases. Sacra of four segments

are much rarer, only one such specimen being encountered in our series (Fig. 4). Adolphi found only one in 292 sacrums, and Fischel but one in 306 instances. An increase in the number of segments is therefore much more common than a decrease.

The number of sacral foramina varies with the number of segments. In sacrums of six segments there are five foramina on each side, and in sacrums of four segments, three. The longitudinal diameter of the first sacral foramen is much greater than the transverse because of the projection of a bony lingula from the medial posterior margin of the foramen. The other foramina are more nearly circular in shape. They decrease in longitudinal diameter

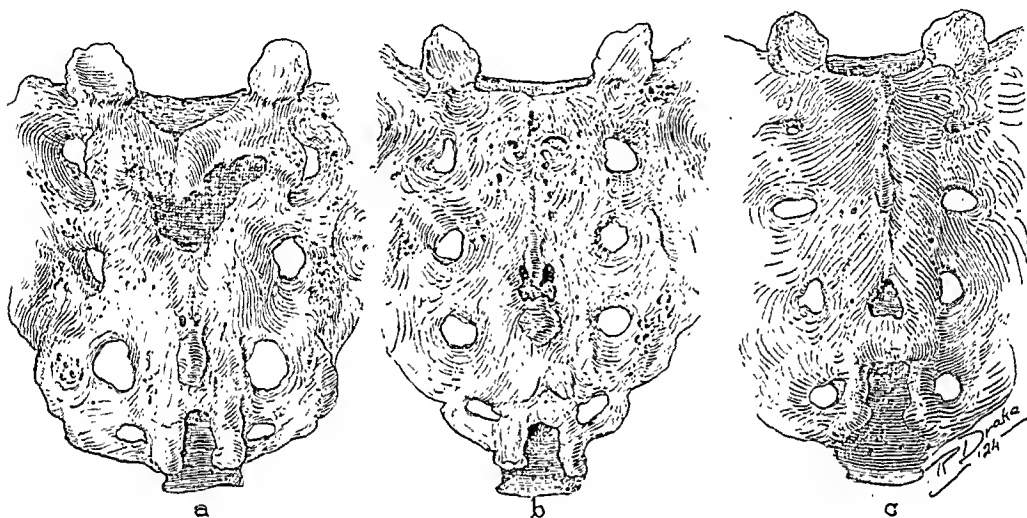


FIG. 3.—Abnormal openings in the posterior sacral wall above the sacral hiatus. *a*, opening between the first and second arches; *b*, between the second and third, and *c*, between the third and fourth. Puncture of the dura would be possible through these openings.

from above downward, the average diameters in our series being: S-1, 10.8 mm.; S-2, 8.3 mm.; S-3, 7.4 mm., and S-4, 6.2 mm. The average distance from the median line to the median edge of the first foramen is 21 mm., and that of the fourth foramen, 15 mm.

Considerable variation was noted in the size of foramina in the different specimens (Fig. 4). Their size does not depend on the size of the sacrum, as is well illustrated by a comparison of the two specimens of the same size, *c* and *d* in Fig. 6. The diameters of *c* were: S-1, 14 mm.; S-2, 12 mm.; S-3, 10 mm., and S-4, 7 mm., while those of *d* were 6, 4, 3, and 1 mm., respectively.

Asymmetry of foramina was not observed, although in certain cases of lumbosacral vertebrae, there were no perfect foramina on the lumbar side, but this is of no significance in the technic of nerve block. Foramina were patent and easily accessible to the needle except in two instances. In these, the right fourth foramen was covered over by a bony bridge (Fig. 4, *d*), which, while not completely closing the foramen, was sufficient to prevent the insertion of a needle passed perpendicularly.

The sacral curve is not, as a rule, equal and uniform in either sex. It is generally flattened above, and has a more pronounced curve below the third

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segment. The absolute depth of the curve is greater in men than women. Also in man the sacrum is more likely to be flattened above, and curved in the lower portion. The depth of the curvature varied from 4 to 44 mm. in

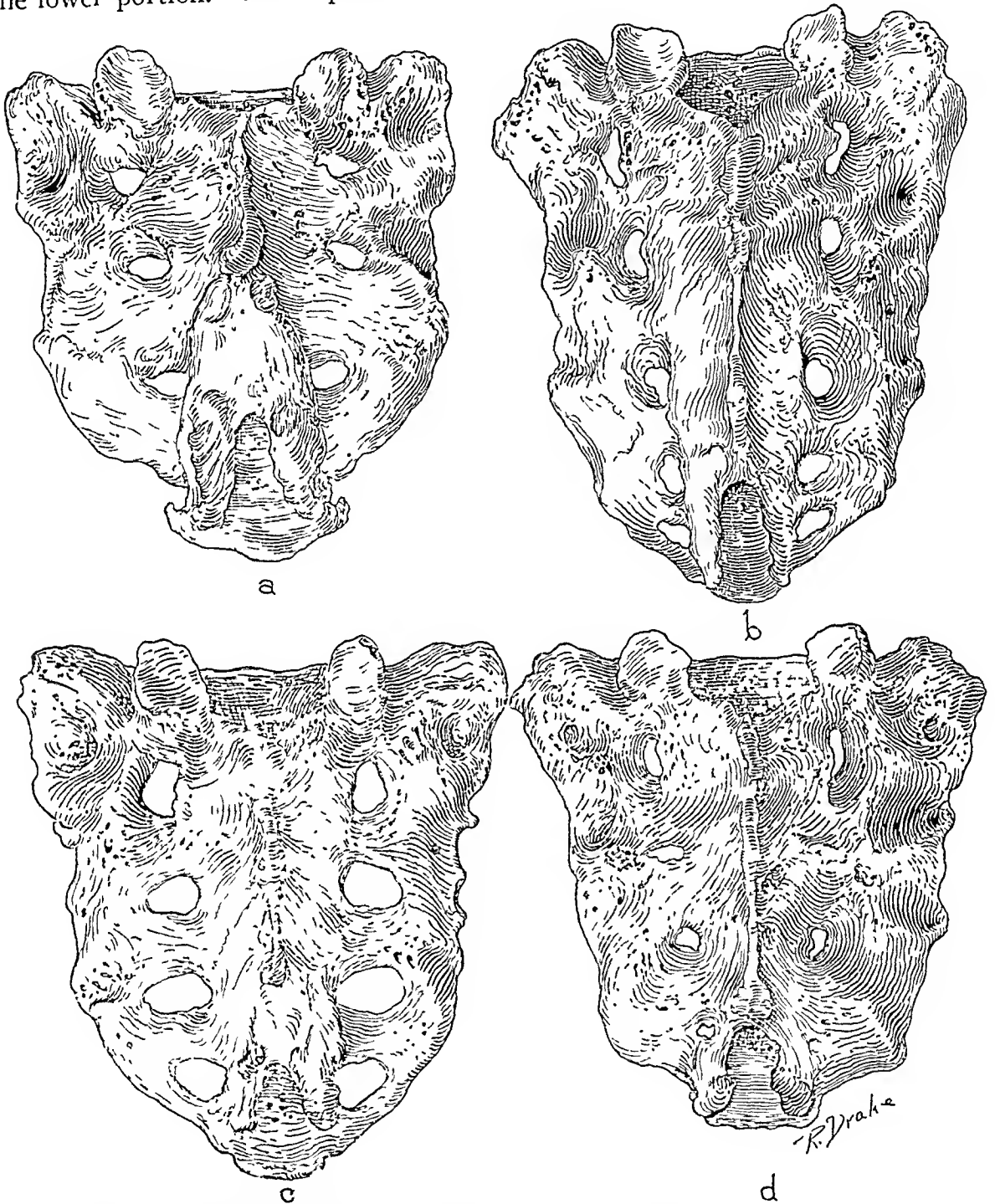


FIG. 4.—Variations in number of sacral segments (*a* and *b*), and size of foramina (*c* and *d*). *a*, is a four segment sacrum, present in less than 1 per cent. of cases; *b*, represents a six segment sacrum present in 20 per cent. of cases; *c* and *d* are sacra of approximately equal size, the foramina of *c* being roughly three times the size of those of *d*. A bony bridge over the right fourth foramen of *d* entirely obscures it.

Peterson's series. In rare cases the sacrum may be convex, particularly in the rachitic pelvis. One such sacrum was encountered in our series (Fig. 5, *a*), while fifteen were almost straight, conforming more to the type, Figure 5, *b*; seventy-nine conformed more to the normal (Fig. 5, *c*), while in seven instances the curvature was greater than normal (Fig. 5, *d*). In the most

marked concavities, the curvature is more pronounced in the lower segments, tending toward a hook-shape, flattened above, and markedly rounded below; when the sacral hiatus is small, the needle can be advanced but a very short distance in the sacral canal.

Asymmetric sacrums are either of traumatic or pathologic origin. There were no such specimens in our series. We have seen twelve patients, however, in whom the canal could not be entered. One was a boy, aged seven years, with congenital deformity of the sacrum and external genitalia. The other was a man, aged sixty years, with an extremely small sacrum, in which neither the caudal nor the lateral foramina could be found. In five cases there was a history of injury and also much palpable deformity. The remain-

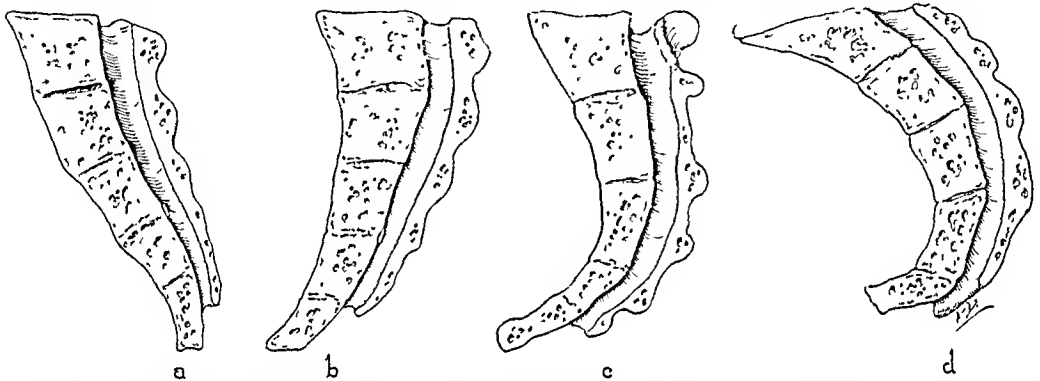


FIG. 5.—Variations in curvature of the sacrum. *a*, a rare instance of slightly convex curvature, probably the result of rickets (1 per cent.); *b*, slightly concave, less than the usual amount of curvature (15 per cent.); *c*, the normal curvature (79 per cent.), and *d*, greater curvature than normal, especially in the lower half (7 per cent.).

ing cases were among the first attempted and were probably due to faulty technic. In most of them satisfactory anaesthesia was produced by injection of the lateral foramina as far as possible, and infiltration of the coccygeal region.

Fractures of the sacrum are rare. The lower end is the portion usually involved, together with the coccyx, so that the resulting deformity is more likely to interfere with the injection of the hiatus than the lateral foramina. In rare instances healed fractures of the pelvis involving the sacrum may present distorted anatomic relations, but since only 0.8 per cent. of all fractures involve the pelvis, and since accompanying internal injuries are usually so severe as to lead to the death of the patient, sacral fractures are only rarely a complicating condition in anaesthesia of the sacral nerves.

Bony outgrowths, tumor formations and healed caries of the sacrum produce atypical deformities. These conditions are also very rare, and present themselves for perineal operations so seldom that they need offer no problem in the technic of sacral nerve block.

Sacral Topography.—Several methods of surface marking for the location of the sacral hiatus and foramina have been proposed. Several surgeons recommend inserting a finger into the rectum, grasping the coccyx and moving it to and fro while palpating for the sacrococcygeal articulation. This manoeuvre is of little actual value. Besides the decreased asepsis of the

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finger, there is the limited motion of the coccyx and the impossibility of recognizing this joint in obese patients. Moreover, the coccyx, particularly the first coccygeal segment, is often completely ossified to the sacrum. Location of the hiatus by this means is usually due more to the identification of sacral cornua by palpation than to the sacrococcygeal joint by manipulation of the coccyx.

As a result of anatomic studies, Lynch recommends that a line be passed from the posterosuperior spine to the opposite sacrococcygeal articulation, and the same on the opposite side, the point of bisection of these lines giving the location of the sacral hiatus. He does not state how the sacrococcygeal articulation is located, which of itself quite definitely determines the location of the sacral hiatus.

The most accurate surface anatomy is that calculated from palpable bony prominences. In the lower sacral region the cornua are the most prominent lateral tubercles, and are almost always definitely palpable, even in obese persons. With the index finger of the left hand the tip of the coccyx is palpated in the anal groove. The finger then follows the smooth posterior surface of the coccyx upward until the two sacral cornua are felt, one on either side. Somewhat higher in the median line the apex of the triangular sacral hiatus crest may be identified, indicating the apex of the triangular sacral hiatus. This is the method of identification originally proposed by Cathelin.

The lateral foramina lie in straight lines on either side of the sacral crest. All authorities select a point just lateral to the sacral cornu for the lower extremity of the surface line, designating these foramina. Danis selects a point 3 cm. lateral to the fifth lumbar spine for the other extremity of a lateral sacral line. Pauchet joins the most prominent points of the iliac crests to form an interiliac line, which usually passes over the fourth lumbar spine. He then selects a point on this line 4 cm. lateral for the upper extremity of a lateral sacral line. Labat selects a point 1 cm. medial to the posterosuperior iliac spine for the designation of the lateral sacral line. In our experience the posterosuperior iliac spines are the most readily accessible bony prominences of the sacral region. Moreover, they bear a more constant relationship to the lateral foramina, and may be defined with greater precision than either iliac crests or lumbar spines. They lie within the sterile field and are considerably closer to the sacral foramina than either lumbar spines or iliac crests, so that any system of sacral topography with iliac spines as the basis must be correspondingly more accurate.

We measured the distance between the most prominent points of the posterosuperior iliac spines in 100 patients, and found the average to be 95 mm. (Fig. 6). We also measured the distance of sacral foramina from the median line in the series of sacrums. In the average adult the lateral sacral line passes through a point 25 mm. medial to the most prominent point of the posterosuperior spine. This spine in lean persons can be seen at once without palpation and is more prominent in men than in women. In the more obese women, in whom Michaelis' rhomboid is well marked, the spines are at

the lateral angles of this rhomboid, since the upper and lower sides are formed by the transverse and sacrospinalis, and the gluteus muscles, respectively.

Position.—Cathelin made the epidural injection with the patient lying on his left side with back arched and knees drawn up. This position has been followed by the Germans. Danis employed the ventral prone position for transsacral nerve block, which has proved to be much more accurate also for the epidural injection. Besides being more comfortable for the patient, the superficial landmarks may be taken with greater accuracy. In the lateral



FIG 6 —Dimensions of the average adult sacrum *a*, the average anteroposterior thickness at the different foramina, *b*, distances between foramina and the relation of the interspinous line to the first and second sacral foramina

position the sacrum is displaced upward, while overlying soft tissues by their own weight hang lower in relation to the bony framework. The fall of the buttocks thus displaces the gluteal cleft at least 1 cm. lower than the sacral hiatus. In the ventral position, on the other hand, the sacral crest is always in the median line with respect to overlying soft tissues, and sacral cornua are equal distances from it. Placing a cushion under the hips raises the sacral region and thus accentuates bony landmarks.

Instruments.—As in any other surgical procedure satisfactory results cannot be obtained with unsuitable instruments, and many of the outfits advertised for use in local anæsthesia are entirely unsuitable. All that is required is the proper supply of needles and a syringe. Self-filling syringes and pneumatic injectors are of no value.

The needles are of much greater importance than the syringe, in block of the sacral nerves. They should be as fine as their stability will permit, thus minimizing the pain and trauma caused by their frequent passage through the soft tissues. There should be an adequate assortment of different lengths, and they should be made of good quality of steel so that a sharp cutting edge is maintained.

The needle used for puncture of the sacral canal is a spinal puncture needle of small calibre and made of a material which will bend but not break. There is danger of breaking a brittle steel needle within the sacrum because of the curvature of the sacral canal.

We have found the Labat syringe and needles very satisfactory in sacral nerve block. Owing to the extreme scarcity of the market supply and excessive price of the Labat outfit, Sharp and Smith have manufactured a syringe and needles according to Meeker's specifications, which we have found entirely satisfactory. The syringe is of 10 c.c. capacity and equipped with rings for

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the hand grasp so that one may aspirate, or refill the syringe with one hand. It has an eccentric tip and is provided with a bayonet lock attachment which fastens the needle on. The needles are of an excellent quality of flexible steel,

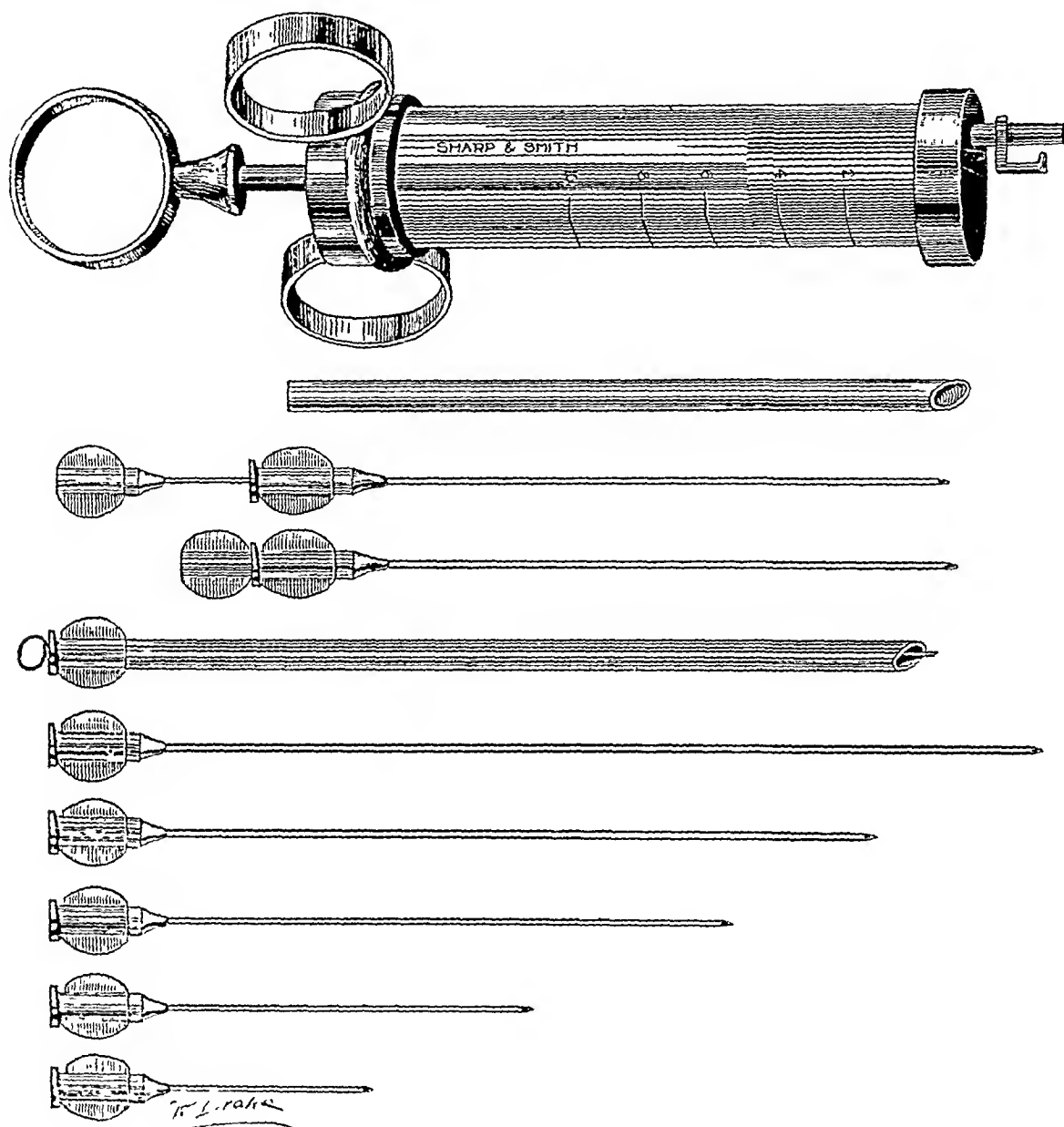


FIG. 7.—Outfit for the induction of local anæsthesia. The glass barrel syringe is equipped with metal mounting and plunger. The tip is eccentrically located and equipped with a bayonet lock attachment. Rings for the thumb and fingers permit aspiration and refilling of the syringe with one hand. The needles are equipped with protecting sheaths and fasten onto the syringe by a locking device.

small in calibre and of different lengths to suit the different anæsthetic procedures (Fig. 7).

Technic.—The cutaneous surface over the sacrum is sterilized the same as in other surgical procedures and the same aseptic precautions followed. The sacral cornua are identified, and with the finest needle a dermal wheal is placed above a line connecting the cornua and in the median line of the body. This wheal marks the centre of the sacral hiatus. The underlying subcutaneous tissues and sacrococcygeal ligament are then infiltrated so that the passage of the larger needle will not cause pain. A spinal puncture needle of small calibre is used in making the sacral puncture (Fig. 9). This should

always be sufficiently small and sharp so that it will never be necessary to incise the skin with a tenotome for the insertion of a coarse spinal trocar. The needle is introduced through the anæsthetized skin over the hiatus, with bevel upward, and forming an angle of between 20° and 30° to the skin surface.^{26, 27, 28, 42, 43} There is a sensation of increased resistance as the sacrococcygeal ligament is reached, and a definite snap is felt as the needle pierces the ligament and impinges on the bone of the anterior sacral wall. Whenever the needle is felt to pierce a dense membrane, pass through a free space, then come in contact with bone, there is no doubt but that the sacral canal has been entered. The needle is then withdrawn very slightly and depressed 20 to 30 farther until it is in a position approximately parallel to the sacral canal, when it is advanced gently and slowly 4 or 5 cm. into the canal, along the median line of the body. It usually passes readily but may strike either the anterior or posterior wall of the canal a short distance inside. If it strikes the anterior wall, depressing the shoulder, or using the finger as a fulcrum placed on the needle 1 cm. from the skin surface, and elevating the hub, will also elevate the point into the centre of the canal. When the needle impinges on the posterior wall, pressure applied on the sacrococcygeal membrane at the site of juncture usually releases it. If these devices are unsuccessful the needle should be withdrawn and re-introduced a little higher.

It is obvious that the ease of sacral puncture will depend on the size of the hiatus and the curvature of the lower sacrum. The easiest cases are those in which there is a partial sacral bifida, which allows the needle to be inserted higher than usual. If the ununited fourth or third sacral arches are not palpable in these cases, patency of the hiatus may be determined by perforating the occluding membrane with the small needle during the preliminary infiltration of tissues overlying the hiatus. The hiatus is small when there is a fourth sacral spine, and especially when it is flattened anteroposteriorly. Thompson, in an examination of thirty-three sacra, found the canal accessible to the needle in all cases except in one cadaver in which the canal was markedly curved and unusually narrow and flattened. In cases of small hiatus associated with marked curvature, it is probably best to perforate the sacrococcygeal membrane with a small needle for infiltration, depending considerably on muscular sense for the proper insertion of the needle. This low sacral injection can then be associated with transsacral block for surgical anæsthesia.

Harris was unable to find an opening into the canal in two patients having a history of injury to the sacral region in early adult life. We have encountered four such patients with marked deformity and considerable bony overgrowth. In three instances in which the Kraske posterior resection of the rectum had been performed with removal of the coccyx and fifth sacral segment, no difficulty was experienced in puncture.

Accidents.—When too much force is used in inserting the needle, or when the patient makes a sudden movement after correct insertion of the needle, the shaft may be broken. Cathelin reports two instances of broken needles

in 1000 injections: one needle broken at the entrance to the canal was readily removed; the fragments of the second were removed from the body of the fourth sacral vertebra at necropsy six months later. It had not caused any trouble. Harris, Pickens, and Lynch have reported instances of sacral insertions in which the needles were broken. In our experience, an assistant made a satisfactory sacral puncture and during injection the patient jumped suddenly, breaking the needle inside of the sacrum. It was necessary to remove the posterior wall of the sacrum before the fragment could be recovered.

Injection of Solution.—After correct insertion of the needle the stylet is withdrawn and the injection begun. When the needle lies correctly, the solution is injected almost without resistance. If considerable force is necessary the point of the needle may be buried beneath the periosteum and should be readjusted. If on injection a subcutaneous swelling appears, the needle has not entered the sacrum, but lies posteriorly in the subcutaneous tissues. This is the most common mistake in sacral puncture.

The solution should be injected very slowly and gently. About half of the total quantity is injected without moving the needle. Withdrawal is begun as the injection progresses, until at the conclusion the needle point lies just inside of the sacrococcygeal ligament. During injection the patient may complain of cramps in the legs, which is proof of correct insertion of the needle and usually indicates too rapid injection. The injection is always painless when not made too fast. In a slow injection the solution diffuses gradually through the tissues of the canal, whereas a rapid injection may cause a collection of solution at the point of the needle, tearing the delicate vascular network of the canal, and resulting in hemorrhage. Læwen advises two minutes for the actual injection of the fluid.

Proper precautions should be observed in order that intradural or intravenous injection will not result. In the average patient the needle is not advanced high enough for puncture of the dura, but in those with partial sacral bifida, in which the needle is inserted higher than usual, and in females, this accident may occur. Zweifel reports a death caused by the injection of 0.8 gm. of novocain into the dural sac. On the appearance of spinal fluid the needle was withdrawn, but insufficiently, death occurring ten minutes later from paralysis of the heart and lungs. Goldenburg mentions a case in which the full dose was injected into the dural sac without causing trouble, save a complete anæsthesia of the lower half of the body for forty-eight hours. Collapse has also been observed, probably from injection into the blood stream. Kronig reports a case of partial respiratory paralysis which he ascribes to injection into a sacral vein.

In order to prevent such disasters one should watch closely for the appearance of blood or spinal fluid as soon as the stylet is withdrawn. As injury to veins may occur without the appearance of blood, aspiration should be practiced with a half-filled glass-barrel syringe before beginning the injection. If either blood or spinal fluid appears, the needle should be withdrawn until aspiration is negative before beginning the injection. Changing the position

of the pelvis we regard as of little value, and we have never seen blood flow from the needle in spurts, as has Schlimpert. We have made dural puncture through the sacral canal four times. In one case, that of a man, the dural sac was entered 1 cm. from the sacral hiatus. The needle was withdrawn slightly until spinal fluid could not be withdrawn with the syringe and the injection then made successfully. In a small woman, spinal fluid was obtained when the needle was 2.5 cm. inside the sacral canal, the dural sac extending abnormally low.

Amount and Strength of Solution.—The quantity and percentage strength of the novocain solution varies in the hands of different operators. L  wen, who first demonstrated the practicability of the method for operative work, recommends from 20 to 25 c.c. of a 2 per cent. solution of novocain and epinephrin with the addition of sodium chlorid and sodium bicarbonate. He also employs from 25 to 35 c.c. of a 1.5 per cent. solution of novocain bicarbonate. Other formulas have also been proposed. Strauss adds sodium sulphate. Harris maintains that the efficiency of the solution is increased by the addition of calcium chlorid, and potassium sulphate has been employed for the same purpose. Bicarbonate of soda, sulphate calcium chlorid, and a number of other drugs were employed in combination with novocain in more than 500 cases in this series in an endeavor to increase the efficiency of the an  sthesia. Our experience has not indicated that the combination of other salts with the novocain results in a more satisfactory an  sthesia.

Time and Extent of An  sthesia.—The an  sthetic effect is more rapid, the nearer the nerve trunk lies to the bulk of the fluid injected, and it varies according to the size of the nerve trunk. In the average case an  sthesia appears first in the anococcygeal area in about four minutes. It radiates from this point, and in ten minutes covers the posterior surface of the scrotum and penis. It spreads laterally down the inner surfaces of the thighs about 10 to 12 cm. Posteriorly there is complete relaxation of the sphincter ani with an area of an  sthesia covering the sacrum and buttocks. The anterior urethra is an  sthetized in from ten to twelve minutes. The meatus and internal sphincters are generally the last to become an  sthetized. In most cases the intensity of the an  sthesia gradually increases, reaching its maximum in from twenty to twenty-five minutes.

The distribution of an  sthesia is variable, especially the height, depending on the size of the sacral canal, the amount of solution injected, and the anatomic arrangement of the sacral contents. In the average case the greatest intensity of an  sthesia is manifested from the second sacral nerve downward. There are occasional instances of light an  sthesia in which the fourth and fifth, or the fifth sacral nerves are the only ones blocked. In many cases, however, the an  sthesia extends beyond these limits as high as the upper lumbar and lower dorsal nerves. Schlimpert and Schneider produced a high sacral an  sthesia sufficient for abdominopelvic operations. They injected large amounts of novocain, and employed deep preliminary hypodermic narcosis. This has proved to be a dangerous method, as toxic manifestations are often

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quite severe. Wiedkopf's collected list of fourteen fatalities, for which local anæsthesia probably was responsible, included nine cases of high sacral anæsthesia. The present tendency, therefore, is to limit the epidural injection to the region of the sacral nerves.

There is considerable difference of opinion as to the influence of gravity on the spread of the injected solution. In high sacral anæsthesia the sacral region was elevated, the patient assuming the knee-chest position so that the solution would ascend to a higher level. The sitting posture has been employed by some so that gravity would keep the solution low in the sacral canal. In the lateral position it has been observed that anæsthesia occasionally is more marked and ascends to a higher level on the side on which the patient lies. While gravity may sometimes exert a slight influence, we believe that the solution diffuses through the tissues of the sacral canal more because of capillary attraction, and is usually little influenced by position. When the anæsthesia is higher on one side, it usually means that most of the injection has been made on that side of the sacral canal. We have observed a case of right-sided anæsthesia in a patient injected in the left lateral position. In two cadavers injected by Perrill, the fluid was confined to one side of the epidural space because thin fibrous bands formed a partial septum in the epidural cavity. In cases of complete failure of sacral anæsthesia, when the injection has been correctly made, it is logical to assume that there are such planes of cleavage which may localize the anæsthetic medium to one area.

In making the injection the sacral hiatus or caudal opening is located in the usual manner, the patient lying on his abdomen with hips elevated. In the majority of cases, an ampule, put out by Metz, containing 1 gm. of novocain in 5 c.c. of sterile distilled water, is used. Approximately 95 c.c. of sterile distilled water is brought to a boil in a sterile beaker, removed from the alcohol flame, and the contents of the ampule added. The mixture is allowed to cool, and 6 drops of a 1 : 1000 epinephrin solution added. The needle is inserted from 3 to 4 cm. into the sacral canal and from 50 to 75 c.c. of the mixture injected very slowly, allowing from six to ten minutes for the entire injection.

The chief disadvantage of caudal anæsthesia is its failure in a certain percentage of cases, particularly in the more extensive operations on the perineal and anal structures. While the proportion of failures varies according to the accuracy with which the technic is performed, the method, because of anatomic variations, is accompanied by a certain incidence of failure, even in the hands of the expert. The anæsthetic, because of the curvature of the sacrum, is deposited nearer the posterior wall, while the anterior divisions of the nerve trunks lie contiguous with the anterior wall. Moreover, the nerve trunks are exposed to the action of the anæsthetic solution more laterally where they are not protected by dural sheaths. The solution must thus diffuse through the contents of the epidural space before physiologic block of the nerve trunks will be effected. Even when successful, the height of anæsthesia is variable, extending from the anal margin in light anæsthesia to complete motor paralysis of the legs in extreme cases. However, if one is ready to

supplement the sacral injection by local infiltration when required, failure to induce a satisfactory surgical anaesthesia will be rare.

Other disadvantages are the delay after injection before the appearance of full anaesthesia, fifteen to twenty minutes being required, and occasional toxic manifestations. Consequently, we have limited sacral anaesthesia, mainly to the superficial operations on the perineum and terminal rectum, to urologic examinations, and to obstetrics. It is the method of choice for cystoscopy and painful proctoscopy.

Transsacral Nerve Block.—Block of the sacral nerves by the transsacral method, in the opinion of many operators, has overcome many of the incon-

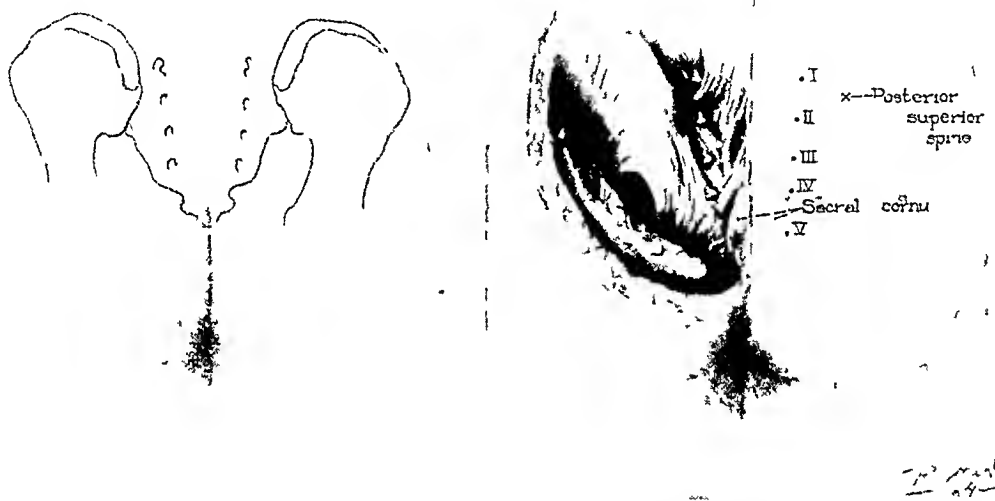


FIG. 8.—Topographic anatomy of the sacral region. The female figure to the left shows the rhomboid of Michaelis, and the relation of the posterior superior spines to the lateral angles of this rhomboid. On the male figure to the right is shown the relation of cutaneous points over the foramina to posterior superior spines and sacral cornua.

veniences and disadvantages of the sacral and parasacral methods. We find that the best results are obtained by the use of a very low epidural injection for anaesthesia of the fifth sacral and the coccygeal nerves, and transsacral block of the upper four sacral nerves. This technic gives a uniformly satisfactory surgical anaesthesia of a definitely limited height.

Technic of Transsacral Method.—With the patient in the same position as for the caudal injection, the lateral foramina are injected. The posterosuperior spine is identified, and a dermal wheal placed 2.5 cm. inward and 1 cm. downward, which in the average case marks the second sacral foramen. Another wheal is placed just lateral and below the sacral cornu which represents the sacral notch or fifth sacral foramen. The distance between is divided into three equal parts by two more wheals, thus defining the third and fourth foramina. The first is then located by a wheal placed 2.5 cm. above that which marks the second foramen, following the same straight line (Fig. 8).

The thickness of the soft tissues overlying the sacrum is much greater

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above and less below, which necessitates the employment of needles of different lengths in searching for the various foramina. Less discomfort is given the patient when the smallest needle possible is employed in searching for a given foramen. Usually an 8-cm. needle is used in perforating the skin over the second sacral foramen. It is inclined somewhat downward and slightly inward until it is thought to be perpendicular to the tangent of the sacrum at that point. It is then gently advanced until it either comes in contact with bone or passes through the foramen. If it comes in contact with bone it is gently withdrawn and another search for the foramen made. In this way the distance from the periosteum to the skin is estimated, and when, after repeated attempts, the needle seems to perforate a membrane, advances farther than before and still does not encounter bony resistance, it has passed into the foramen. It is unusual to insert the needle directly into the foramen at the first attempt. If this should occur, it would probably be better to withdraw the needle, direct it somewhat more obliquely, and locate the margin of the bone more superficially, thus verifying the correctness of the first position. The needle may then be re-inserted in the original position.

The needle in the foramen is usually left in place to serve as a guide while search is made for the third foramen. A 5-cm. needle is employed for the next two lower foramina. After injection of the third and fourth foramina, the 10-cm. needle is inserted into the first sacral foramen. This foramen lies deepest of all, and prolonged search is often necessary to locate it. In order that the needle may advance perpendicularly to the plane of the sacrum, it must be inclined more toward the surface of the skin than in the other foramina. The foramina of the opposite side are next injected in the same manner. When both sides have been injected, the skin over the coccyx is tested for anæsthesia with a clamp. If it is insensible to pain the fifth sacral foramina are not injected; otherwise, they are injected in the manner described.

After a little experience, six-segment sacrums may often be recognized by the increased distance from the cornua to the posterosuperior iliac spines. In such cases the second sacral foramen is nearer the interspinous line, so that often it is best to search first for the third or fourth foramen before marking the others with dermal wheals. Having located one foramen, the needle is left in place and foramina above and below are located, using the first as the starting point.

Faulty technic may be rapidly improved by a study of the human skeleton and practice on a cadaver. It is important to remember the greater thickness of the overlying tissues near the base of the sacrum. If the needle is to be advanced perpendicularly to the tangent of the sacrum at any given point, there will be the greatest obliquity to the surface of the skin in searching for the first foramen, less for the second, and scarcely any at all for the lower three foramina. Lateral inclination of the needle should be guarded against, as after osseous contact the needle may be directed more laterally and pass entirely off from the sacrum.

The needles should be introduced a greater distance into the upper than into the lower foramina. It is best to make the injection anterior to the median point of the foramen, moving the needle somewhat to and fro. Our measurements of the thickness of the sacrum at the different foramina indicate that inserting the needle 2, 1.5, 1, and 0.5 cm. into the sacrum in injecting the first, second, third, and fourth foramina, respectively, would be most accurate.

Quantity of Solution.—The amount and strength of the solution employed varies with the size and resistance of the patient. For greatly debilitated patients and for relatively poor surgical risks, a solution of 0.5 per cent. strength is used, the amount being gauged more or less by the probable size of the sacrum. From 20 to 40 c.c. of the solution is injected into the sacral canal, then the sacral foramina are injected according to their size and the size of the nerve trunk to be blocked. The greatest amount should thus be injected into the first foramen, and the quantity for each successive foramen reduced by 1 c.c.: that is, 7, 6, 5, 4, and 3 c.c., respectively. From 75 to 140 c.c. of the 0.5 per cent. solution has given uniformly complete anæsthesia. When a 1 per cent. solution is employed, as is usual in robust persons, from 20 to 25 c.c. is injected into the sacral canal and the posterior foramina in the same ratio as with the 0.5 per cent. solution. From 60 to 100 c.c. of a 1 per cent. solution has in all cases produced complete physiologic block. Ten drops of epinephrin are always added to each 100 c.c. of solution.

Proper precautions must be observed in the preliminary preparation of the patient and in the search for the foramina so that the procedure will not be too painful. The proper preliminary narcosis of morphin and scopolamin should be given when needed, the amount being determined by the patient's age, weight, and general resistance. The dose should be sufficient to allay apprehension, but not to produce a state of somnolence or twilight sleep. In many weak, debilitated, and bedridden patients, and particularly in the aged, no preliminary narcosis is necessary. For the average adult, morphin $\frac{1}{6}$ gr., and scopolamin $\frac{1}{200}$ gr. are given an hour before operation. Often, if patients are robust and of more than average weight, the dose must be repeated from one-half to one hour after the first administration.

The greatest pain in searching for foramina is caused by making the dermal wheals, but it is transitory and usually well tolerated. In highly sensitive patients, ethyl chlorid has been recommended to anæsthetize the skin for the entrance of the needle, but we have found this to be unnecessary. While making the initial prick with the fine needle the thumb should be on the plunger, so that at the moment the needle enters the skin the solution can be injected instantly. In this way the puncture may sometimes be made without the patient's knowledge. If the needles are sharp and bright there is no further pain unless the periosteum is roughly probed, which besides causing pain, bends the sharp point of the needle to a hook so that it tears the tissues when withdrawn and requires more force for penetration. Such needles should be discarded at once. Pain may occasionally be produced by

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advancing the needle directly into a nerve trunk. The pain is sharp and lancinating, and is radiated through the pelvis to the genitalia or down the legs according to the nerve trunk reached. When this occurs the needle should be withdrawn from 1 to 2 mm. so that a perineural, and not an endoneural, injection will be made. An endoneural injection of a large nerve trunk with the same amount of solution required for block by diffusion of this solution after perineural injection is more likely to injure the nerve trunk and result in post-anæsthetic pain.

Therapeutic Application.—While Cathelin is usually given credit for suggesting the feasibility of sacral anæsthesia, his epidural injections were for the purpose of medication of the sacral nerves. He employed these injections in the treatment of sciatica, lumbago, the painful crises of tabes dorsalis, enuresis, and sexual neuroses. As the result of his experiences in more than 1000 injections, he regarded it as a valuable therapeutic measure in pathologic conditions involving the sacral nerves.

The most common therapeutic use of epidural injections in the Clinic is in the treatment of sciatica. Ott reports results in a series of forty-eight cases in which the sciatica pain was not due to diabetes, caudal tumor, or other causes of so-called sciatica. Repeated epidural injections, with the removal of possible foci of infection in a large percentage, resulted in permanent cure in 29 per cent., and in permanent amelioration of symptoms so that the patient was able to continue his occupation with a fair degree of comfort in 37 per cent. In the remaining 34 per cent. no permanent beneficial results were obtained.

These injections also seem to have a certain definite value in the treatment of intractable pruritis ani and vulvæ. Smiley reports thirteen cases of anal and genital mixed pruritis relieved by this means, in eight of which other medical and surgical measures had failed to relieve. In pruritis ani he regards epidural injections as more satisfactory than surgical procedures. His patients usually required from two to four injections four or five days apart. We have known a case of intractable pruritis ani and vulvæ of long standing to resist all other forms of treatment, and to clear up promptly after a single epidural injection. Others, however, do not respond after repeated injections, the percentage of such cases being probably about the same as in the treatment of sciatica.

Most of Cathelin's original work on injection of the sacral nerves was carried out in an endeavor to cure incontinence. He reported good results. We have treated a number of cases of enuresis and incontinence by sacral injections, but without signal success. However, a number of these persons are incontinent as a result of some underlying pathologic condition, disease in the bladder, prostatic urethra, or a definite nerve lesion. We have injected repeatedly in several cases both normal salt solution and weak solutions of novocain. A small number of cases of incontinence may be the result of minor nerve defects or they may be psychic or habitual. Advice as to general measures, together with an impressive procedure, such as sacral anæsthesia,

may have a temporary effect on some patients. In several cases definite cures were obtained, but it is difficult to determine the rationale of the treatment in these cases; in the majority no change was produced in the degree of the incontinence. It was impossible to determine that the sacral anæsthesia was definitely the cause of improvement in any case.

Obstetric Anæsthesia.—Stoeckel first investigated the value of epidural injections in the control of the pains of childbirth. By the use of 30 c.c.

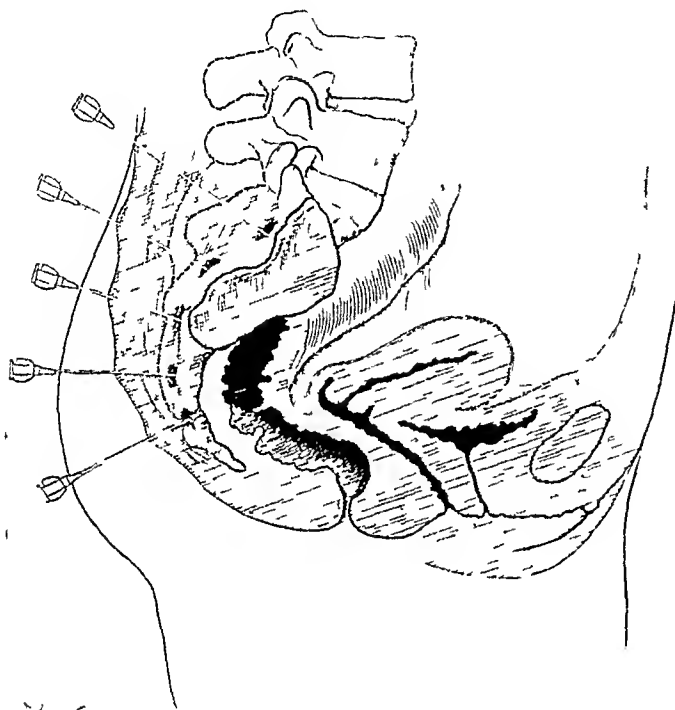


FIG. 9a.—Median longitudinal section of the pelvis anterior to the sacrum. The shaded portions represent the extent of anæsthesia. Note the variable thickness of tissues over the sacrum, and different direction of needles in entering the different foramina.

of a 0.5 per cent. novocain solution he materially reduced the pains of parturition, and in four cases terminated labor by the application of low forceps. Meeker and Bonar have recently made a study of the value of sacral nerve block anæsthesia, both by the single epidural injection and by the transsacral method in a series of ninety obstetric cases. From the standpoint of the anæsthetic, better results over a slightly longer period of time were obtained by the transsacral method, but the difficulties in the execution of transsacral

block in the parturient make the epidural method the more practical, even though the height of anæsthesia is variable. All obstetrical operations in which the operative field lies within the area innervated by the sacral nerves can be painlessly performed under sacral nerve block anæsthesia. The unmistakable relaxation of the pelvic floor facilitates any operation attempted by way of the genital tract. Twenty-one forceps deliveries have been performed, of which ten were low, eight middle, and three high. The perineal relaxation not only facilitates the application of the blades, but shortens the duration of the operation, and reduces the number of perineal tears. The obstetrician is not only able to apply traction during uterine contractions, but also to induce the patients to cooperate by bringing their abdominal muscles into action. Other intra-uterine manipulations have been done, and tears of the cervix and perineum painlessly repaired.

During normal labor the patients were instructed to bear down and urged to greater voluntary effort during the uterine contractions. Without proper

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instruction and encouragement the parturients were likely to rest and delay the progress of birth until the pains were felt again.

The effect on the uterine contractions was inconstant. In the majority of cases there was almost complete cessation of contractions within ten minutes after the injection was completed. This diminution rarely lasted more than twenty minutes; the contractions then increased gradually in frequency, duration and intensity until after a short time they proceeded normally.

The greatest difficulty was the selection of the proper time to induce anaesthesia. There was a tendency to induce it too early in primipara and too late in multipara. In many cases, also, the time of delivery could not be accurately foretold, so that injections were repeated in some instances as many as three times. In average cases the maximal benefit from the injections was obtained when dilatation of the os had reached at least 7 cm. in primiparas and 4 cm. in multiparas. When, as the result of a patient's coöperation, labor terminated during the period of anaesthesia, it was without the usual noisy outcry, and often the patient was unaware that the baby had been born. Other patients felt dull pressure as the head slipped over the perineum. In many cases the perineum slid back from the head with such ease that the obstetrician was surprised, because a tear had seemed inevitable.

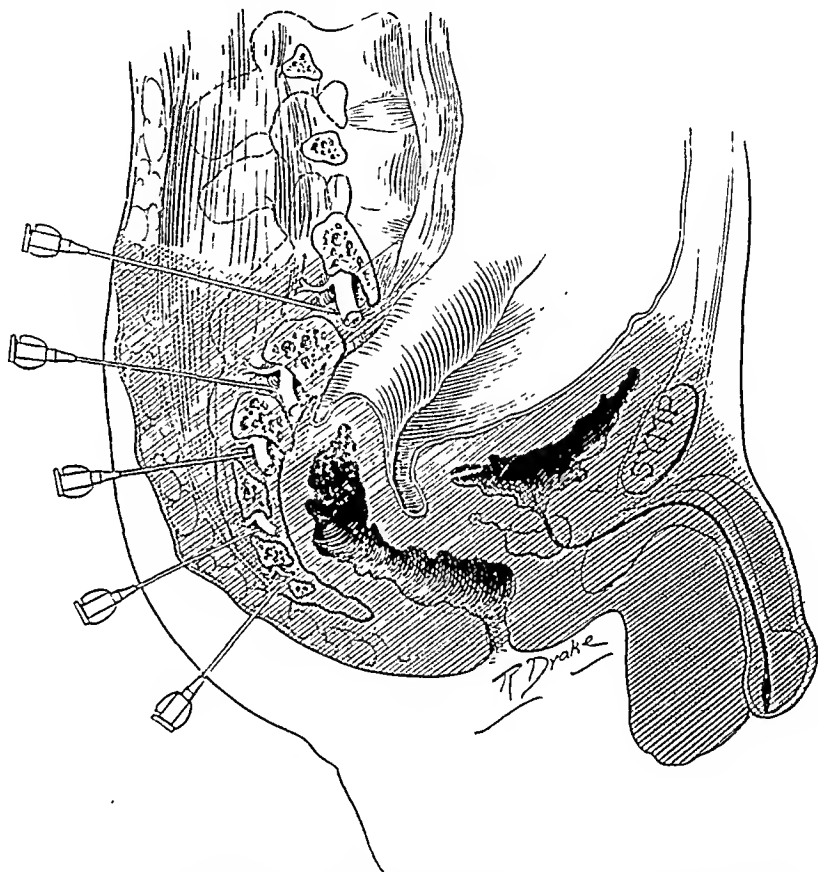


FIG. 9b.—Median longitudinal section of the pelvis anterior to the sacrum. The shaded portions represent the extent of anaesthesia. Note the variable thickness of tissues over the sacrum, and different direction of needles in entering the different foramina.

Surgical Anæsthesia.—It is in anaesthesia for operations involving the pelvic floor and viscera that block of the sacral nerves is most useful (Fig. 9). For two and one-half years, until January, 1924, we employed it in a large number of cases (Table I).

The total number of failures was 97 (5 per cent.). All cases in which the sacral anaesthesia had to be supplemented by general narcosis were regarded as failures, even if the stage of analgesia was not passed. Since the patients in this series were not selected, several were included who were mentally incompatible with local anaesthesia, and inhalation narcosis had to be

TABLE I
Block of the Sacral Nerves

	Cases	Failures	Per cent.
<i>Operations on the prostate and bladder.</i>			
Prostatectomy	270	16	5.92
Resection of bladder for carcinoma	32	3	9.37
Resection of bladder for diverticulum	8	3	37.5
Urologic examinations and manipulations	585	27	4.61
<i>Operations on the rectum and anus.</i>			
Posterior resection of rectum (Kraske)	151	18	11.92
Hemorrhoidectomy	325	6	1.84
Anal plastics (Fissures, fistulas, sinuses, excision of specimens, and so forth)	144	5	3.47
<i>Operations on the vagina, uterus, and perineum.</i>			
Vaginal hysterectomy	12	5	41.66
Perineorrhaphy	18	2	11.11
Amputation of cervix	15	3	20.
Combined perineorrhaphy, coloporrhaphy and repair of cervical tear or amputation of the cervix	54	4	7.4
Dilatation and curettage of the uterus	13	2	15.38
<i>Obstetrics</i>	90	1†	1.11
<i>Therapy.</i> (Sciatica, pruritis ani, enuresis, incontinence, and so forth)	54		
<i>Miscellaneous</i>	46	2	4.34
Total	1817	97	5.33

† Repeated injections were employed in obstetric work which accounts for the low incidence of failures.

resorted to for psychic reasons, even though block of the sacral nerves was complete. In a few instances the operation was delayed too long after block of the sacral nerves. In other instances the operation extended to structures outside of the anæsthetized field, as in transabdominal resection of the bladder and the combined abdominoperineal removal of cancer of the sigmoid.

Anæsthesia in Urologic Surgery.—The urologic surgeon, more often than any other, deals with persons having diminished function of the kidneys. An anæsthesia that will not appreciably increase the work of the kidneys, such as sacral anæsthesia, is desirable. The majority of patients presenting themselves for relief of prostatic hypertrophy or disease of the bladder, are usually well along in years, and frequently have also an associated urinary obstruction and renal insufficiency. Renal infection and chronic nephritis are common, and are responsible for the majority of deaths following prostatectomy and resection of the bladder. The anæsthesia employed is very closely associated with the incidence of undesirable post-operative sequelae in cases of urinary obstruction. Ether unquestionably predisposes to complications of the pulmonary and cardiorenal type, and the incidence of post-operative bleeding, which greatly increases the liability to urinary infection is, comparatively, quite high following spinal anæsthesia.

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The epidural injection is very satisfactory and usually sufficient for perineal prostatectomy, but for operations on the bladder and for suprapubic prostatectomy, a complete transsacral nerve block is carried out, after which the patient is placed on his back for anæsthesia of the suprapubic region. A field block of the abdominal wall is employed, which results in greater relaxation than infiltration of the line of incision. This facilitates the use of retractors and results in better exposure. ..

The suprapubic field block is also applicable in the second stage of prostatectomy, in which the suprapubic sinus is to be dilated. Wheals are placed above each pubic spine, then along the outer margin of the rectus abdominalis muscle, usually three on each side. After piercing the skin at the lowest wheal, deep injections are made beneath the abdominal aponeurosis in the same straight line at the outer rectus sheath. Perforation of the aponeurosis is easily recognized by the increased resistance to the advancement of the needle. After perforation the needle is advanced no further, but an injection from 1 to 2 c.c. of solution is made. Successive perforation and injections are made in this manner along the entire outer margin of the rectus, almost as high as the umbilicus. When the deep injections have been completed, subcutaneous, fanwise injections are made in the same plane, joining the wheals together. The same procedure is repeated on the opposite side. A longer needle is then passed obliquely downward behind the pubic bone and into the space of Retzius, where an injection of 10 c.c. of solution is made.

For suprapubic field block, from 125 to 175 c.c. of a 0.5 per cent. novocain solution is necessary, depending on the size and obesity of the patient.

All patients have been placed in the Trendelenburg position; the same retractors and other instruments have been employed as in other methods of anæsthesia, and the operations performed in a similar manner.

Anæsthesia in Prostatectomy.—During the last three years 526 prostatectomies were performed: 270 under sacral anæsthesia, 187 under spinal anæsthesia, and sixty-nine under ether anæsthesia.

Transsacral anæsthesia is well tolerated by old men, and in no case were there undesirable complications attributable to the anæsthesia. Not infrequently the patient experiences a sense of distress or deep-seated pain during the period of enucleation of the prostate. This was especially noticeable in the subvesical and small, fibrous types of prostate, in which it was necessary to pull strongly on the tissues around the neck of the bladder in order to free the prostate. This discomfort was usually well borne, rarely lasted more than a few seconds, and the patient was without pain immediately after the enucleation. In sixteen cases (5.8 per cent. of 270) it was necessary to supplement the sacral anæsthetic with a general anæsthetic: ether, nitrous oxid, or ethylene. In several of these cases the general anæsthesia was only of short duration and was employed more for its psychic than for its anæsthetic effect. A certain number of patients object to being awake during the course of the operation and demand a general anæsthetic. These cases must necessarily be included with the group of either partial or complete

failures. The percentage, 5.8, probably represents the minimum of failures in this type of case.

A somewhat similar percentage, representing the group of actual failures of the anæsthetic, and cases in which general anæsthesia was demanded, is found in operations performed under spinal anæsthesia. In eleven (6.5 per cent.) of 167 prostatectomies performed under spinal anæsthesia, a general anæsthetic was required for completion of the operation.

The anæsthesia used in the cases of prostatectomy during the last three years, together with the immediate operative and late mortality, is shown in Table II. Statistics for cases in which spinal and ether anæsthesia were employed are given in order to form a basis of contrast among the three types of anæsthesia.

TABLE II
Comparison of Different Types of Anæsthesia for Prostatectomy

	Patients	Per cent.	Hospital Patients	mortality Per cent.
Sacral	270	51.33	9	3.33
Spinal	187	35.55	13	6.95
Ether	69	13.12	5	7.24
Total	526		27	

The introduction of sacral anæsthesia has unquestionably been a factor in the lowering of the operative mortality following prostatectomy. The operative mortality in cases in which sacral anæsthesia was employed is less than half that following prostatectomy under either ether or spinal anæsthesia. In patients recovering from operation, there was no difference in the late results following the different types of anæsthesia. Sacral anæsthesia does not entirely eliminate the possibility of respiratory infection, which, when it occurs following the administration of ether is usually attributed to pulmonary irritation from the anæsthetic. One patient in this series died from pneumonia and pericarditis forty days after operation. Sacral anæsthesia definitely eliminates the group of immediate deaths usually attributed to shock and cardiac disease. The earliest death in this series was on the fifth day, and followed post-operative hemorrhage and urinary infection; one death on the eighth day was due to uræmia, and the remaining seven deaths, in cases in which sacral anæsthesia had been employed, occurred from thirteen to forty days post-operatively, but in no case was there any definite causal relationship between the sacral anæsthesia and death.

Anæsthesia in Resection of the Bladder.—The success of sacral anæsthesia in resection of the bladder depends mainly on the extent of the resection and the tissues involved in the malignancy. Usually the sensation of the parietal peritoneum is not affected by sacral anæsthesia, but opening the peritoneum causes pain. Not infrequently, in tumors of the dome and posterior wall of the bladder, the peritoneum covering the bladder is involved and must be

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resected. This usually requires a general anæsthetic. In the majority of cases of vesical neoplasm in which the peritoneum is opened, it is desirable to explore the abdominal cavity for metastasis, and a general anæsthetic is given. Occasionally a deep anæsthesia is produced which permits incision and exploration of the peritoneum; in certain cases intestinal resection may be carried out, but when the anæsthesia is induced in the usual manner, this is rare.

Anæsthesia in Operations for Carcinoma of the Bladder.—Sacral anæsthesia, together with suprapubic field block, was employed in forty-two operations for carcinoma of the bladder. In ten cases the tumor was too extensive for removal; radium emanations or needles containing radium were inserted in the growths in five cases, and in the remaining cases the bladder was drained. Ether was given in one case before the bladder was incised; there was a large tumor filling the entire bladder. In thirty-two cases resection of the bladder was carried out, in certain of which as much as one-half of the bladder was removed. Ether was required in three cases: in one case, that of a morphine addict who required ether before operation, a very small amount was given; in the second, a transperitoneal resection of the bladder was performed, and in the third, multiple tumors of the bladder were resected.

In four cases the peritoneum was opened and sutured to the base of the bladder below the tumorous growth, or else a transperitoneal resection was carried out. In only one of the four cases was the sacral anæsthesia insufficient to complete the operation. In three cases in which one ureter was transplanted to a normal area of the bladder, the sacral anæsthesia was sufficient. Only one patient died following operation. Death occurred on the seventh day from pneumonia and multiple abscesses in the heart and kidney.

Diverticula of the Bladder.—Diverticula of the bladder occasionally are very large, extending high up behind the bladder in an area not supplied by the sacral nerves. In dissecting out large diverticula an extensive area is usually opened, and the peritoneum is occasionally adherent to the sac. There were eight cases in which a diverticulum of the bladder was resected. Ether was required in three. In one of these the prostate was also removed (only one ounce of ether was given). In another there was a large diverticulum extending under the base of the bladder. In the third case the diverticulum was only of moderate size, but ether was necessary during the entire resection.

Urology.—In the majority of cases extensive anæsthesia is not necessary, but there is a certain percentage of patients who require complete anæsthesia of bladder and urethra. Etherization must be very deep to obtain relaxation of the bladder, and like spinal anæsthesia, it necessitates hospitalization. The restless movements of the patient under general anæsthesia greatly interfere with the accuracy and expediency of the examination. In contrast to this, the patient under sacral anæsthesia is perfectly quiet, conscious and able to coöperate, and the bladder is dilated to a point impossible save with some form of nerve blocking. The wall of the bladder is completely relaxed; there

is no pain or straining, which permits the surgeon to make a thorough, unhurried examination of the bladder and ureters. Sacral anæsthesia was induced in 585 cases for urologic examination. (Table III.)

TABLE III

Results of Sacral Anæsthesia in Patients Operated on, Treated, or Examined for Urologic Conditions

	Cases	Satisfactory	Results Failures
<i>Operations and treatments.</i>			
Radium needles	111	105	6
Transvesical treatment of bladder tumors:			
Fulguration	31	31	0
Radium emanations	27	27	0
Urethral operations	25	24	1
Litholapaxy	31	30	1
Manipulation of ureteral stones	51	51	0
Prostatic punch	17	17	0
Cystoscopic examinations:			
Tuberculous cystitis	74	72	2
Malignant cystitis	63	58	5
Alkali phosphate cystitis	9	9	0
Pyelocystitis	126	115	11
Bladder stone	8	8	0
Submucous ulcer	2	2	0
Miscellaneous	10	10	0
Total	585	559	26

As a general rule, a single caudal injection gives sufficient anæsthesia for a complete cystoscopic examination. In cases in which a single caudal injection is insufficient, or in which it is impossible to enter the sacral hiatus, it is necessary to inject the lateral foramina. Usually an injection of the first and second nerves is sufficient.

Failure to induce complete anæsthesia by caudal injection most commonly occurs in small contracted bladders, such as are found in extensive tuberculous infection. In cases of malignant tumors of the bladder, the growth may involve a large area of the bladder wall or may have extended through the bladder wall to neighboring structures. In such cases, distention of the bladder may affect structures not anæsthetized by a caudal injection. There were no failures in cases in which either the first or the second, or all of the lateral foramina were injected together with the caudal foramen.

Sacral anæsthesia is usually very satisfactory in irritable, inflamed bladders, especially those of tuberculous origin. In contracted, painful bladders which must be emptied every ten to fifteen minutes, the instrument is passed painlessly, the anæsthesia permitting a distention of from 100 to 150 c.c. during the entire examination, without a tendency to discharge. With sacral

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anæsthesia, it is possible to add the extra ounce or two of fluid which usually determines whether cystoscopic examination is to be a success or a failure. A distention may be produced with sacral anæsthesia sufficient to flatten the folds of mucosa and expose the entire surface of the bladder. There is paralysis of the sensory arc, and the reflex spasm, that often makes complete examination impossible, is absent. The patient rests quietly; stertorous breathing and the shifting bladder walls under deep narcosis are absent.

Sacral anæsthesia may be substituted for the usual perineal infiltration preliminary to the introduction of radium needles into a carcinomatous prostate. With a local infiltration it is difficult to eliminate deep pressure pains caused by the needle passing through the board-like malignant tissues of the capsule and prostate gland. After blocking the sacral nerves, the anæsthesia of the perineal tissues, the prostate and its covering is so complete that the needles are often passed without the knowledge of the patient. More radium needles may be inserted than when a local infiltration is used; the radium-containing tips are more accurately placed and the field of operation is not obscured by the œdema caused by the infiltrating solutions.

In the majority of cases of benign papilloma of the bladder, fulguration may be carried out without extensive anæsthesia, but occasionally there is an associated cystitis which will not permit sufficient distention for a satisfactory fulguration. In a number of cases, multiple papillomas were fulgurated over a long period of time without discomfort to the patients.

In cases of lithopaxy, when washing out stone fragments, it is necessary to remember that the musculature of the bladder is partially paralyzed by the anæsthetic, and cannot readily expel the water and particles of crushed stone. The Bigelow evacuator has been used satisfactorily to overcome this difficulty.

Temporary paralysis of the sphincter muscle may produce a slight incontinence, particularly after the introduction of a large instrument such as a lithotrite. This relaxation usually disappears with the return of sensation. Sacral anæsthesia produces excellent relaxation of the lower ureter and permits the manipulation of ureteral stones. In certain cases a number of ureteral catheters may be inserted readily without causing the patient discomfort. Occasionally there is relaxation of the lower ureteral segment and a spasm of the upper ureter which causes an impassable angulation. This angulation may occur following an injection of all the lateral foramina as well as after a single caudal injection. In some persons it is present repeatedly following subsequent injections, making it impossible to introduce the ureteral catheter. In such cases, some other type of anæsthesia should be employed.

Operations on the Rectum.—Sacral anæsthesia has been repeatedly employed for hemorrhoidectomy, the usual type of operation being clamp and cautery of the internal hemorrhoids, and excision and suture of the external. Dilatation of the anal sphincter is one of the characteristic features of the method, reducing to a minimum the use of manual or instrumental dilatation. Plastic operations on the anal sphincters, removal of rectal polypi, dilatation

or rectal strictures, excision of specimens from rectal tumors for diagnosis, painful proctoscopy, amputation of the prolapsed rectum, and posterior resection (Kraske) of the rectum, have all been performed many times under this anæsthesia.

The anæsthesia in the minor operations on the terminal rectum offers no special problem since the patients are usually in good general condition. Among patients suffering from cancer of the rectum, however, are many with associated nephritis, pulmonary and cardiac complications, general weakness, malignant cachexia, and secondary anæmia. In such conditions as these the advisability of eliminating the extra burden imposed on the vital organs by a general anæsthetic is quite obvious. The anæsthetic hazard in these cases may be considerably lessened by the use of sacral nerve block anæsthesia, which does not, as a rule, affect the general condition of the patient.

Buie has recently completed an interesting statistical study of the surgical results in carcinoma of the rectum at the Mayo Clinic between January, 1910, and December, 1922. He showed that the surgeons are becoming more radical in their attempt to help more patients, which is evidenced by the increase in the operability of cancers of the rectum and rectosigmoid from 56 to 84 per cent. during this period. In spite of the extension of operability, the mortality has gradually decreased. It is quite probable that the improved pre-operative preparation and the improvement in surgical methods and technic are to a great degree responsible for this gratifying result. The increasing use of the two-stage operation is doubtless a contributing factor, while the use of sacral anæsthesia has materially reduced the risk of operation. The height of the growth is also a factor influencing mortality, which is 18.3 per cent. for growths in the rectosigmoid, and 7.44 per cent. for those in the rectum. We have made a statistical study of posterior resections of the carcinomatous rectum over a period of six years, ending January, 1924. The total number of such operations during this period was 392, with a post-operative mortality of thirty-four (8 per cent.). Any death occurring in the hospital following operation was charged as an operative mortality, even if the complications which caused death arose in the lung, kidney or other organs. One hundred and fifty-one resections were performed under sacral anæsthesia, with a mortality of 7.3 per cent., and 241 were performed under general anæsthesia, with a mortality of 9.5 per cent.

Among the 151 nerve block cases we listed eighteen as failures because the administration of a general anæsthetic was necessary at a certain stage of the operation. When there is intolerable pain it is due to excessive traction on the bowel necessary to bring a high-lying growth down so that clamps may be applied above it. This traction is probably on the mesosigmoid, involving the hypogastric nerve plexus, and cannot be controlled by block of the three lower lumbar nerves. This same trouble is observed with low spinal anæsthesia. Block of the sacral nerves alone anæsthetizes the entire pelvic floor, including the pelvic peritoneum, so that there should be no pain when this is opened, stripped from the rectum, or closed.

Sacral nerve block is not appropriate for the removal of high-lying growths by the combined abdominoperineal method. One of our failures was in the case of a sigmoidal growth which had produced complete intestinal obstruction for five days by intussusception. The sacral nerves were blocked and the abdominal wall anæsthetized by field block. The intra-abdominal manipulations were painful, necessitating the use of ether, since no intra-abdominal anæsthesia was afforded by the local anæsthetic procedures.

Gynæcologic Operations.—Operations performed on the genital tract under sacral nerve block have included carcinomatous ulcers of the vulva, perineorrhaphy, complete vaginectomy, the Bovée and Clark operations for cystocele, trachelorrhaphy, dilatation and curettage with insertion of the Baldwin tube, repair of vesicovaginal fistulas, excision of vaginal tumors, the Watkins interposition operation, and the Mayo vaginal hysterectomy.

In malignant growths of the vulva it is best not to rely on circular infiltration because of the wide extirpation necessary and the possibility of the spread of cancerous foci. Sacral nerve block affords a very wide area of anæsthesia, and is very efficient when used alone in these cases, unless the external anterior parts of the labia majora are to be included in the operative field, in which case infiltration from the pubic spines must also be practised.

Vaginectomy has been performed in relaxed pelvic floors after hysterectomy in which the pelvic peritoneum was painlessly opened and closed. Repair of cystocele may be painlessly performed. Multiple perineal operations, such as dilatation and curettage, trachelorrhaphy, perineorrhaphy and hemorrhoidectomy, have been performed on the same patient under one anæsthesia.

It is in the Watkins interposition operation and the Mayo vaginal hysterectomy that the borderline of usefulness of the sacral method is reached. In these operations, particularly the hysterectomy, the most difficult problem is the prevention of traction pain. Vaginal hysterectomy in this series was most commonly performed for uterine prolapse. The majority of the patients were obese, and had passed the menopause. The anæsthesia of the pelvic floor was usually satisfactory and the peritoneal cavity could be opened painlessly. Delivery of the fundus of the uterus through the vaginal and peritoneal opening for clamping of the broad ligaments is usually the stage at which most pain occurs. Usually a small gauze pack is temporarily placed in the peritoneal cavity to prevent the intestines from protruding. Structures not supplied by sacral nerves, and consequently not anæsthetized, are thus encroached on. There is also tension in approximating and suturing the broad ligaments after the uterus has been removed.

This pain from traction on the broad ligaments cannot be controlled by parametric injections, since the same amount of tension is still present beyond the area infiltrated, the parametric injections serving only to anæsthetize the uterus itself. In cases of marked relaxation and complete prolapse, therefore, the anæsthesia is usually sufficient for hysterectomy and may be followed by perineorrhaphy.

There were twelve cases of vaginal hysterectomy in this series. Seven of the patients were past sixty, and two past seventy years of age. Three weighed over 200 pounds. In five cases it was necessary to add ether or gas oxygen to the sacral anæsthesia during the deep manipulations, the combined method probably offering a bigger margin of safety in poor risk cases than general narcosis alone.

Miscellaneous Operations.—Various minor operations have been carried out on the urethra, vagina, and rectum, and in the superficial tissues of the buttocks and gluteal folds. Vesicovaginal fistulas were repaired in twelve cases. There was almost always complete anæsthesia of the vagina and of the lower portions of the bladder. In an occasional case, in which multiple repairs had been previously carried out and there was an extensive defect requiring considerable tension to close over, discomfort was experienced by the patient, but in no case was it sufficient to necessitate a general anæsthetic. In twelve cases a ureteral plastic operation for incontinence was performed. In the majority of cases the Kelly type of plastic repair with plication of the muscular covering on the posterior wall of the urethra was made. Vaginal operations were performed in nine cases: in one case a carcinoma of the vulva and vaginal wall was removed. In a second case a vaginectomy was performed, and in the others various types of plastic operations.

In three cases coccygectomy was performed. The area at the tip of the coccyx, anæsthetized by the lower sacral nerves, is the first to become anæsthetized, and no discomfort was caused by the removal of this bone. In three cases pilonidal sinuses were excised, and in two, cysts of Bartholin's glands were removed.

Complications and Sequelæ.—The concomitant complications of sacral anæsthesia are, as a rule, not severe, provided the procedure has been properly executed. Most patients react more or less to the injection of novocain-epinephrin solutions into the sacral canal and foramina, the severity of the reaction depending on the strength and quantity of the solution, the amount of epinephrin, the speed with which the injection is made, and especially the sensitiveness of the patient to the effects of epinephrin and novocain.

The most common complications are rapid pulse and palpitation of the heart, most likely due to the epinephrin, although Lowsley reports the same effects in using a 2 per cent. novocain solution without epinephrin. Increase in the pulse rate from 20 to 30 beats a minute is usual, the patient at the same time experiencing a pounding sensation with the heart action. Sometimes there is precordial distress, and more rarely a sensation of constriction across the chest. In a few instances the pulse has been very markedly accelerated, in one instance reaching 180 for a time. A rise in blood pressure with the increase in pulse rate is usual. This is observed during, and immediately after, the injection and lasts but a few minutes. These complications, when marked, may be accompanied by an increased respiratory rate and dyspnœa, pallor, perspiration, and a feeling of giddiness. Still more rarely there may

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be nausea and vomiting. Four patients had short periods of excitement, the longest being fifteen minutes. Patients may very rarely have a definite psychosis and require restraint. These four were somewhat confused temporarily, but after the conclusion of the excitement stages the operations were performed without incident. When such sequelæ appear, the injection should be stopped until they improve. Judging from our experience, they need cause no serious concern.

Cases of rigor, convulsion, syncope and collapse have been reported. Death has followed high sacral anæsthesia. There is no actual danger in the method when the correct technic is used and the anæsthesia restricted to the nerve distribution of the pelvic organs.

There may be pain and tenderness at the site of the sacral injections for from four to five days, depending on the amount of searching necessary to locate the foramina. In cases of prostatectomy this was aggravated by the patients bearing their weight on the sacral region, and soiling with urine. There were three cases of infection of the area of injection with sloughing of the tissues over an area from 2 to 4 cm. in diameter. All three cases followed prostatectomy in thin patients. Since then such patients have been supplied with air cushions, and no further trouble has arisen.

SUMMARY

Anæsthesia of the sacral nerves is entirely satisfactory for most operations that are to be carried out in the field supplied by the sacral nerves. It entails practically no immediate or late risk for the patient, and has been proved very efficient and satisfactory.

A knowledge of the posterior surface of both normal and abnormal sacrums and contiguous bony prominences is necessary in order to employ sacral anæsthesia successfully. Certain variations of the structure of the sacrum may influence the ease of induction or the result of the anæsthetic. The size of the sacral hiatus is variable. In the majority of sacrums the closure of the hiatus is over the fourth, occasionally over the third, and rarely over the first or second sacral vertebra. In a small number of cases there is an entire deficiency of the roof of the sacral canal.

The normal sacrum is made up of five vertebra. Sacrums of six segments are frequently encountered, but sacrums of four segments are much rarer, only one such specimen being encountered in our series. The number of foramina to be injected varies with the number of segments. In the normal sacrum there are four foramina on each side. The foramina in the second sacral segment is the largest, and usually the most readily located and entered. The individual foramina, usually circular in shape, decrease in diameter from the first to the last segment.

The sacrum is usually flattened above and has quite a pronounced curve below the third segment. Traumatic, or developmental deformities of the sacrum are extremely rare and usually do not interfere with the induction of the anæsthesia.

Palpation of the bony prominences gives the most accurate knowledge of the location of the sacral hiatus and foramina. The posterosuperior iliac spines are the most readily accessible bony prominences and they usually bear a constant relationship to lateral foramina.

In certain cases in which the operation is to be performed in a field supplied by the lower sacral nerves, a single injection of novocain in the sacral hiatus is sufficient. In the majority of cases the lateral foramina and the contained nerves, as well as the sacral hiatus, were injected, inducing immediate anæsthesia which is satisfactory in practically all cases. A 1 per cent. solution of novocain, to which was added a small amount of epinephrin, was employed. Our experience has not indicated that the combination of other salts with the novocain results in a more satisfactory anæsthesia.

Sacral anæsthesia was employed in 1817 cases at the Mayo Clinic. Satisfactory anæsthesia was not obtained in 97 (5.33 per cent.) of the cases. The highest percentage of failures occurred in cases in which extrapelvic structures, not supplied by sacral nerves, were encountered.

Sacral injections for therapeutic purposes were carried out in the treatment of nervous conditions, and a proportion of cases of sciatica were definitely improved, but they were of very little practical value in the treatment of urinary disorders such as incontinence and enuresis.

In obstetric cases sacral anæsthesia has proved very satisfactory in reducing the perineal pain incident to the passage of the child, and it also permits a satisfactory relaxation of the perineal muscles, which greatly reduces the tendency to tear. Obstetric operations and manipulations may be painlessly performed under this anæsthesia.

Anæsthesia of the sacral nerves has proved entirely satisfactory for most surgical procedures on the pelvic floor and viscera. It is especially satisfactory in urologic cases. The mortality following operations on the bladder, prostate and rectum is markedly reduced in cases in which sacral anæsthesia is employed. In urologic surgery many patients are encountered having a reduced renal function. Sacral anæsthesia, which in most cases does not increase the work of the kidneys, is especially desirable.

Cystoscopic examinations and urethral and bladder manipulations may be readily carried out under sacral anæsthesia. Small contracted, infected and malignant bladders may be dilated sufficiently to make a complete, unhurried examination without discomfort to the patient. A single injection in the hiatus sacralis is sufficient for the majority of cystoscopic examinations and manipulations.

Undesirable complications and sequelæ are exceedingly rare following sacral anæsthesia. In no case did any permanent or lasting trouble develop. Occasionally in debilitated patients slight toxic symptoms followed the injection of the novocain-epinephrin solution, but these readily passed off; in the majority of cases the patient was perfectly well following operation and had no ill effects from the anæsthetic.

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ADOLESCENT COXA VARA*

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FROM THE MAYO CLINIC

COXA VARA is a deformity of the hip which is characterized by a depression of the neck of the femur in relation to the shaft. The angle which the neck makes with the diaphysis is altered from 130° to more or less a right angle; the bending in the adolescent type takes place at, or close to, the epiphysis. Besides the lowering of the head, this type presents an incurvation backward, accompanied by torsion of the neck in its longitudinal axis.

Historical.—Fiorani, in 1881, first gave a clinical description of coxa vara, and Müller, in 1888, first established the relationship between the clinical syndrome and incurvation of the neck of the femur; his description is said to be based on a specimen obtained by resection undertaken for supposed tuberculosis of the hip. Kocher, in 1894, at a surgical congress in Berlin, first suggested the name coxa vara for the condition. Kernisson, in 1897, published a paper on the differential diagnosis of coxa vara and tuberculous disease of the hip. Up to this time the only etiologic factor, apart from the congenital type, was rickets; other hypotheses now began to arise, such as the static, infectious, and traumatic, the last being intimately associated with the name of Whitman, who asserted that coxa vara often, if not always, occurs in adolescents, consequent to fracture or slipping of the epiphysis of the neck of the femur.

General Considerations.—The angles of inclination, of declination, of Alsberg, and of extension may be used in the diagnosis and in measuring the degree of coxa vara. The angles of inclination and Alsberg are common to all types of coxa vara, the other two angles are entirely confined to the epiphyseal or adolescent type, the former measuring the incurvation of the neck, the latter the rotation of the neck in its longitudinal axis. The angle of extension is most important from the point of view of diagnosis, and is measured by noting the increase in the range of extension, without producing lumbar lordosis by Thomas' test, with the patient at the edge of the table, and noting the increase in the range of extension.

Pathology.—The bending seems to take place at or near the epiphyseal line; the femoral head seems lowered, but in reality it is the trochanter which is raised. Besides lowering the neck, it is incurved behind, and usually twisted on its longitudinal axis. The neck seems to bend just at the cotyloid margin, so that the posterior surface appears shortened and the anterior surface

* This work was carried out at the Shropshire Orthopædic Hospital, Oswestry, England.

prominent and lengthened. In the X-ray¹ the head appears distinctly semi-lunar in outline, the cotyloid cavity lengthened longitudinally and diminished transversely, taking the form of an ellipse. In a certain proportion of cases there are also chronic arthritic changes. The cartilaginous covering of the femoral head disappears from its lower part, and sometimes encroaches on the superior border of the neck. The angle of declination, usually 12° , may become negative.

The factor² at work in producing the incurvation of the neck, and its



FIG. 1.—Röntgenogram before treatment.

twisting on a longitudinal axis is the iliofemoral ligament, one of the strongest in the body and extending from the anterior inferior spine to the anterior intertrochanteric line. This ligament fixes the leg in extension and offers considerable resistance to the external rotators of the thigh. When both attachments are approximated by a movement upward of the great trochanter, hyperextension takes place, and the external rotators take over the mastery, producing external rotation of the leg as a whole. This appears to give a satisfactory explanation of the incurvation of the neck, and the rotation of the neck on a longitudinal axis, both of which are really secondary to the elevation of the great trochanter.

ADOLESCENT COXA VARA

The influence of injury is still a much debated point; in most cases there is a history of injury, sometimes even a slight one, in other cases repeated injuries of a minor nature; in yet a smaller group there is no history of injury. The traumatic theory is not sufficient in itself to explain this type of coxa vara. First, there appears to be a juxta-epiphyseal softening and a slow giving way of the neck in that region, which may or may not have been accelerated by slight injury. A large proportion appear to give way gradually for a considerable period; others after giving way slowly for a time appear to give

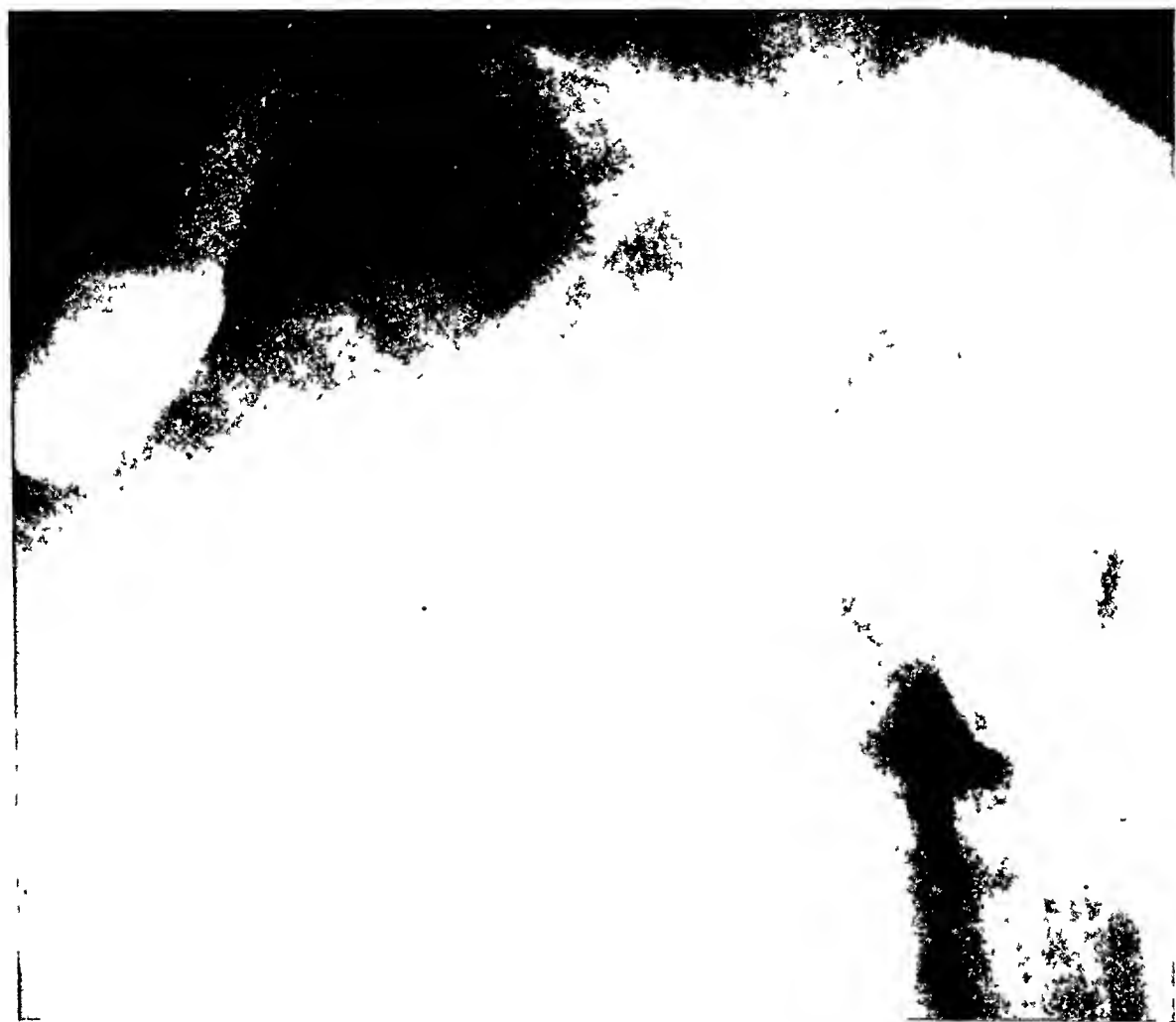


FIG. 2.—Röntgenogram after treatment.

way quickly, probably owing to trauma. Such juxta-epiphyseal softening appears to be something of the nature of late rickets.

There is usually an elevation in the superior border of the neck, said to be an osseous reinforcement. It appears to be too far out for the epiphysis, but probably is the site of the original displacement.

The neck shows modification of structure according to Wolf's law, softening and atrophy of the superior part, with reinforcement by compact bone in its lower part.

Clinical Study.—Adolescent coxa vara comes on usually between the ages of twelve and eighteen years. The onset is sometimes marked by pain, but

often is quite insidious. The pain is usually associated with the rapid slipping, and sometimes at this stage it may be mistaken for coxalgia. The pain of a gradually produced coxa vara is slight; the deformity comes on gradually, elevation of the pelvis takes place on the affected side, and limping and limitation of movement result. The region of the hip is deformed, the great trochanter rises to a higher level than its fellow, and there is both apparent and real shortening.

Both active and passive movements are limited according to the extent of



FIG. 3 —Röntgenogram four months after treatment.

the deformity. The great trochanter rises above Nélaton's line and is further back than normal. Bimanual palpation, that is, the thumbs on the anterior superior iliac spines, and the forefingers on the tips of the great trochanters, gives a good approximate estimate of the relationship on the two sides.

The triple deformity of the femoral neck produces a three-fold limitation of movement, abduction, flexion and internal rotation. In extreme cases the abduction is limited by the great trochanter coming in contact with the dorsum ilii.

There is an increase in the range of extension which, without producing an under lumbar lordosis, is of value in differentiating the condition from

coxalgia. If untreated, the deformity steadily progresses and may go on for years, sometimes until the epiphysis is united, but often a much better result is obtained when the slip gives way suddenly and produces marked deformity, than if the hip gives way slowly.

Arthritis a Complication.—In certain cases in which there has been arthritis of one or both hips, the neck seems to soften adjacent to the head, and a slow bending takes place, producing the triple deformity, as in adolescent coxa vara, in some cases slowly, in others suddenly.

Treatment.—According to Whitman, there are three principles of treatment: (1) Correction of deformity, (2) fixation of fragments, and (3) protection during the period of reconstruction. Repair of solutions of continuity in the neck of the femur takes place by internal callus alone; external callus plays no part in the union; therefore the quality of fixation must be good, and this can be obtained by direct pressure.

From the standpoint of treatment, patients with adolescent coxa vara may be classified in two groups: (1) Those seen early before the bones have been allowed to fix in the deformed position, and (2) those seen late when bony union has been allowed to take place in the deformed position.

Group 1.—Under general anæsthesia, tenotomy of the adductors, forcible abduction and slight internal rotation are accomplished. This treatment is applicable to cases of sudden or gradual displacement; in both types a slight, soft crepitus is felt as the bones go into apposition. Fixation with the patient under anæsthesia, wide abduction with slight internal rotation for three months, and weight-bearing caliper for six months, is the usual form of treatment.

Group 2.—If the deformity has been allowed to become fixed by bony union uncorrected, subtrochanteric osteotomy and wide abduction should be accomplished. The abduction should be confirmed by the X-ray, so that the new angle formed by the neck and the shaft forms about 125° to 130° ; the hip should then be fixed for three months in plaster. When there are marked arthritic changes associated with coxa vara, especially in bilateral cases, the head of the femur should be excised.

Early diagnosis is important. All cases of slight injury to the hip during adolescence should be carefully X-rayed, and a weight-bearing caliper applied, if there is any suspicion of coxa vara.

ABSTRACT OF A TYPICAL CASE

J. M., a boy aged fifteen years, was examined June 12, 1922. Two months before he had fallen from a tree; he got up and walked home, but he limped and felt slight pain, which continued. Six weeks later he again fell, and since then had been unable to stand or walk.

Examination.—The right leg was in the position of eversion and adduction. The great trochanter was displaced above Nélaton's line. There were a few degrees of painless movement in all directions, but mostly in extension. The X-ray revealed adolescent coxa vara of the right hip. Operation was performed June 14, 1922. Tenotomy of adductors and forcible abduction with internal rotation were accomplished. October 3, 1922, the

patient was allowed to get up in a weight-bearing caliper. April 14, 1923, the caliper was discontinued. The range of movement in the hip was good (Figs. 1, 2 and 3).

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THE RECONSTRUCTION OPERATION FOR ARTHRITIS DEFORMANS OF THE HIP-JOINT*

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THE reconstruction operation may be defined as a mechanical adaptation of a hip-joint disabled by injury or disease to the essential requirements of locomotion. It was originally devised for ununited fracture, particularly for a class of cases in which the neck of the femur had been in great part absorbed or worn away, so that direct union of the fragments by any means was doubtful, and in which, even at best, function must be greatly impaired by loss of the neck and consequent limitation of abduction. In this operation the head of the femur is removed and the trochanter is cut from the shaft in an oblique direction with all

its attached muscles so that the additional area thus obtained, together with the part of the neck that remains, may provide a secure weight-bearing surface. The reconstructed neck having been inserted into the acetabulum, the limb is abducted sufficiently to

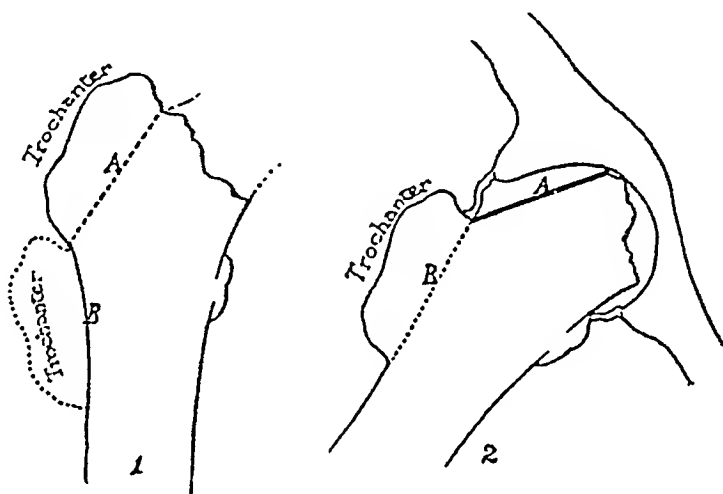


FIG. 1.—Showing complete loss of the neck after fracture of the neck of the femur. 2. Shows the reconstructed neck and the area obtained from removal and transplantation of the trochanter.

permit the trochanter to be drawn down and implanted upon the outer surface of the shaft. Thus by muscular tension, security of the new articulation is maintained, while the reconstructed neck and the transplanted trochanter restore the leverage for the hip muscles and permit a range of controlled motion that enables the patient to walk with security and to sit with comfort.†

Recently the scope of the operation has been enlarged to include a number of other conditions, such as pathological dislocations or subluxations secondary to disease, in which the articulation has been in part destroyed. Cases of this class which require reformation of the acetabulum are not included in the present discussion, which is limited to the operative treatment of arthritis deformans.

In typical cases of this type, the disease practically limited to the hip-joint, is of the so-called hypertrophic or degenerative form, affecting primarily the cartilage and underlying bone of the femoral head, as distinct from the generalized or infective group in which the soft parts are primarily involved.

In characteristic cases the disease is of long standing, beginning with

* Demonstrated before the New York Surgical Society, December 12, 1923.

† Surg., Gyn. and Obst., June, 1921.

indefinite symptoms of pain and discomfort in the joint and limb—"sciatic rheumatism."

The limitation of motion and the discomfort on changing from rest to activity become more noticeable and eventually the limb assumes an attitude of flexion and adduction, the compensatory upward tilting of the pelvis being mistaken usually, for actual shortening. At this stage a crutch or cane is required for locomotion and the patient, from an industrial standpoint, is practically disabled.

The etiology is obscure, but whatever may be the remote predisposing or exciting causes of the disease, constitutional or local, irregularities of the joint surfaces, either the result of congenital malformation or induced a great influence on its by injury or disease, have inception, and more especially on its progress when established, the articulation being gradually worn away and distorted by friction and pressure.

Of the seven cases that form the basis of this paper, five were in females. Three of the seven, including the two males, were typical cases of "*morbus coxæ senilis*"



FIG. 2—Case I. X-ray taken ten months after the operation, showing the extremity of the neck and the transplanted trochanter

both as to age, symptoms and pathological appearances. The fourth was in a woman of forty-eight years of age. The symptoms had become persistent twelve years before admission, but she had had since childhood, occasional discomfort in the joint. The pathological changes were similar to those of the preceding cases, but the cause may have been an incongruity induced by disease or deformity acquired in early life.

In the fifth case, a woman of middle age, the symptoms had followed a fall on the hip four years before admission which, if a fracture, had not caused immediate disability. At the operation only a part of the head and neck remained, indicating apparently a so-called absorption following injury.

In the sixth case, in a woman of forty-five years of age, the symptoms

RECONSTRUCTION OF THE HIP-JOINT

were first noticed after the birth of a child five years before, but if they were the result of infection, it was of a very subacute type.

The seventh case was in a woman forty years of age. The symptoms had been noted eight years before and had increased noticeably after the birth of a child two years later.

It would appear that the disease, at least in the typical form, usually begins in the head of the femur and that the cartilage first disappears on its inner and upper surface. The underlying bone loses its resistance and becomes flattened or otherwise distorted. The acetabulum is less directly involved, and the distortion is not marked until the flexion and adduction of the limb concentrates the pressure on its outer and upper border, permitting a subluxation of the joint. It may be noted in this connection that the museum specimens pictured in the text-books are usually of the most advanced type of the disease and quite unrepresentative of the class of cases under consideration.



FIG. 3.—Case I. Showing the pathological changes in the head and the area removed.

If a diagnosis were made at the inception of the disease, after the removal of all possible sources of infection, internal medication, combined with measures designed to improve nutrition, to check the tendency to deformity and to regulate the strain and pressure on the joint, might check progressive disability. But in advanced cases, such as those under consideration, treatment by rest or traction or splinting can be but palliative; for from the character of the disease it is evident that only removal of friction, the direct cause of pain and of the progression of the destructive process can assure permanent relief.

The usual operative remedy has been arthrodesis to induce bony ankylosis. This, however, is an uncertain outcome because abduction of the limb, the attitude of election, separates the upper surface of the head from the acetabular roof to which it should be apposed in order to secure union, and in a large proportion of cases, although sufficient restriction of motion may be assured after prolonged fixation to relieve pain, there is recurrence of a certain degree of flexion and adduction deformity after the support is removed. Fixation at the hip in patients of this class entails also the disadvantage that assistance is required in dressing.

The only alternative to arthrodesis has been resection, an operation recently described by Groves (*Br. J. Surg.*, Oct., 1923). The head of the bone is removed through a posterior incision and the extremity of the neck, covered with a fascial flap, is inserted into the acetabulum. This operation is effective in removing the disease, but it is defective from the functional standpoint because the trochanter is brought into contact with the rim of the acetabulum thus mechanically limiting abduction. This is a very important

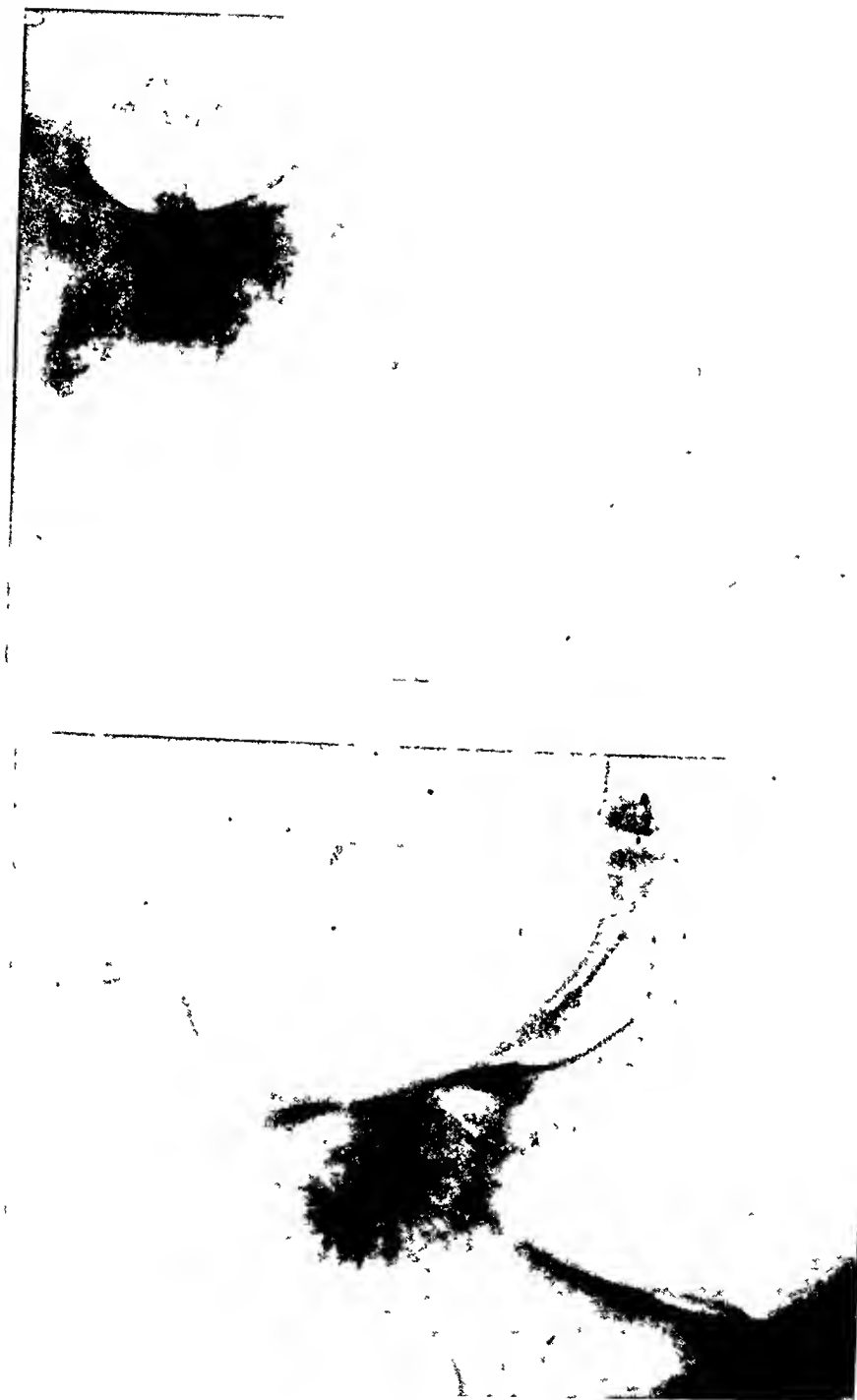


FIG. 4.—Case IV. Showing the expansion of the head and the atrophy of the bone.

FIG. 5.—Case IV. After operation.

RECONSTRUCTION OF THE HIP-JOINT

FIG. 6.—Case III. Showing hypertrophy and subluxation.



FIG. 7.—Case III. After operation, illustrating fixation of the trochanter by a bone screw. Operation performed by Doctor Wagner of the Assistant Staff.



defect because in proportion to lessened muscular control, physical weakness or limited motion, the more essential for security is the crutch-like support of an abducted limb. This ability to spread the legs apart is dependent upon the length and angle of the femoral neck and the lateral projection of the trochanter which assures muscular leverage.

In considering the operative relief of arthritis deformans at the hip-joint from the functional standpoint, the objects to be attained are, in



order of importance: 1st, the removal of a destructive process and thus to check progressive disability; 2nd, security in weight bearing, which implies a sufficient range of abduction; 3rd, the restoration of a fair degree of voluntary motion.

From this standpoint the reconstruction operation has manifest advantages over other treatment. It is conducted as follows:

The incision is in the shape of a half U, begins an inch below and behind the anterior superior spine and crosses the femur at a point about three inches below the apex of the trochanter. The deep fascia is dissected backward and the interval between the tensor vaginae femoris and gluteus medius opened, exposing the capsule. With a wide chisel the base of the trochanter is then separated from the shaft in the line of the neck and with its attached muscles is turned upward. The capsule is opened and with a large curved chisel the greater part

FIG. 8—Typical arthritis deformans in a man of sixty years, showing subluxation. Operation, November 19, 1923. Plastic spine removed, December 17. Patient free from pain and walking with crutches on January 7, 1924. Crutches discarded, March 19, 1924. Now walks with cane and considers the result perfectly satisfactory.

of the head is removed, the design being to include all the cartilage, the marginal exostoses and as much of the underlying bone as may be involved in the degenerative process, including in some instances a part and in others, all of the femoral head. This articulating extremity is made round and smooth with a chisel and file, and is then inserted into the acetabulum the cartilage of which, except on the outer and superior margin, is usually fairly normal. And since in the abducted attitude there is little direct contact between the two there would seem to be no necessity for covering the neck with fascia, although this has been done in some instances in which the bone seemed particularly soft. A thin

RECONSTRUCTION OF THE HIP-JOINT

section of bone with the overlying muscle in the form of a flap, is turned back from the upper and outer surface of the shaft and the limb having been adducted sufficiently, the trochanter is brought down so that its base may be apposed to the bare surface on the outer part of the shaft, where it is fixed by deep sutures through the overlying tissues or by a bone screw. The wound is closed in layers and a long plaster spica is applied in the extended and abducted attitude. This remains for several weeks in order to assure the fixation of the trochanter in its new position. The after-treatment will vary according to the circumstances of the patient. If early locomotion is desired, as in the cases in which the hospital expense is a burden, a short spica extending only to the knee holding the limb in about 20° of abduction is applied and the patient is discharged on crutches, weight bearing being permitted if it causes but little discomfort. In cases which remain under supervision the limb is usually suspended from a frame by pulleys, and passive and later voluntary movements are begun, regulated by the degree of discomfort. The most important factor in the after-treatment being persistent, methodical stretching of the limb outward to the proper degree of abduction and backward to complete extension, thus checking the tendency toward the former attitude of flexion and adduction and resulting compensatory shortening of the limb.



FIG. 9.—Case II. Showing the bone removed and the condition of the cartilage.

As all the operations have been performed practically within a year and several very recently, one can not report on final results. The first operation was performed in November, 1922. This was a typical case of morbus coxæ senilis. The patient, a chauffeur, sixty years of age, was completely disabled because he could not get in or out of his car. When last seen he stated he could walk five miles and that he could sit with comfort. The immediate effects in all the cases have been satisfactory. The deformity of the adducted limb and tilted pelvis has been corrected, the range of motion increased, and the pain on movement and weight bearing has been reduced to discomfort. It would appear furthermore, that the patients may be assured of progressive improvement as contrasted with progressive disability and that the results already attained have substantiated the theory on which the treatment has been based.



FIG. 10.—Specimen removed from Case VII.

TRANSACTIONS OF THE NEW YORK SURGICAL SOCIETY

Stated Meeting Held May 14, 1924

The President, DR. EUGENE H. POOL, in the Chair

RADIOTHERAPY IN HODGKIN'S DISEASE

DR. MORRIS K. SMITH presented a boy who had applied for treatment at St. Luke's Hospital Dispensary, September 3, 1919, with a history of swelling of the left side of the neck of three weeks' duration. At this time he was ten years of age. Back of the angle of the jaw on the left side was a mass made up of rather soft discrete glands measuring about $8 \times 6 \times 4$ cm. There was spasm of the sterno-mastoid on that side. In the lower jaw there was a molar tooth with a large cavity. The tonsil on the same side was described as ragged in spite of his having had a tonsillectomy several years before. No further abnormalities noted.

For the next two and one-half months he was treated with local applications. The bad tooth was extracted. The condition improved but the glands did not clear up. A gland was then removed for diagnosis and was reported as typical Hodgkin's disease. An X-ray of the chest at this time was negative for mediastinal enlargement. He was referred for radiotherapy. Two fractional treatments cleared up the nodes in a month's time.

A year later he returned with numerous small nodes which had been present two weeks. Two courses of radiotherapy were given in the succeeding year.

He was next seen in January, 1924, more than four years after original treatment. Mother at this examination thought he tired easily, but he was in high school and took part in games with other boys. He looked a little pale. The whole posterior triangle of the left side of neck was filled with glands, making a mass about 10 cm. in diameter. Just back of the angle of the jaw was a mass of glands under sterno-mastoid about 5×7 cm. Right side of neck, axillæ and groins contain a few tiny nodes not more than are often palpable in health. Spleen not palpable. No mediastinal dulness, no cough. Patient and his mother stated glands varied in size and were more likely to swell in winter. At this time he was referred back to the radiotherapy department, where under treatment the nodes again cleared up.

The notable features of this case are recurrent glandular swelling of the left side of the neck, diagnosed on biopsy as Hodgkin's disease; the apparent restriction of the disease to this area; the prompt response to radiotherapy, and the excellent general health without, at this time, four and one-half years after onset, evidence of the disease. According to the authority of the examining pathologist, the sections obtained from the glands removed from this boy were positively typical of Hodgkin's disease.

DR. WILLIAM B. COLEY said that these cases are difficult to differentiate from lymphosarcoma, particularly with the absence of liver- and spleen-involvement. This was illustrated by a case which he had had at the

RENAL TUBERCULOSIS

Memorial Hospital ten years ago, with a history of tumors of the neck, and which was regarded as a lymphosarcoma. One of these tumors was removed and pronounced by the pathologist of Bellevue Hospital as a lymphosarcoma. About a year and a half later the tumors recurred locally and the patient was referred to the Memorial Hospital as an inoperable case. She then had a mass of glands in the right cervical region, one of which was removed for diagnosis. The condition was pronounced Hodgkin's disease by Doctor Ewing. The patient was treated by prolonged toxin injections combined with the X-ray. During her six months' stay at the Memorial Hospital she showed marked improvement; but later on developed a condition of the lungs which was believed to be metastases, and the case was regarded as hopeless. She was then lost sight of, until eight years later, when Doctor Coley was called in to see her for an acute abdominal condition, which caused her death a few days later. A careful examination at this time by Dr. William A. Downes and himself, failed to show any evidence of the old Hodgkin's trouble.

RENAL TUBERCULOSIS

DR. CHARLES E. FARR presented a woman, thirty years of age, who entered the New York Hospital, June 7, 1919, and was discharged June 21, 1919. She then had a typical attack of acute appendicitis with high temperature, rapid pulse, a rigid and very tender abdomen. There was a history of right-sided pain since childhood with recurrent attacks of indigestion about every three weeks. Operation was performed at once. The appendix was acutely inflamed and apparently about to perforate. It was removed. Exploration showed an extensive tuberculous involvement of the tubes, ovaries and pelvic peritoneum. A bilateral salpingectomy was done and the wound closed. Recovery was uneventful except for a slight breaking down of the wound. This drained a few drops of serum for a long time. Microscopical examination of the tubes showed extensive old lesions of tuberculosis within the lumen but none on the outer surface of the sections examined. The outside was covered with fibrino-purulent exudate.

During this stay in the hospital the urine showed a marked trace of albumen and a few white blood corpuscles. There was considerable acetone and diacetic acid. There were no urinary symptoms and the frequency of urination was normal, three to five times a day. Recovery was uneventful, the general health improved and she returned to work, against advice. Pain in the right side continued. The menses were normal, regular and painless.

In February, 1920, micturition became frequent and painful with some blood for a period of two months at the onset. Frequency ran up to fifty times per day and the pain was excruciating. Pain in the lower left abdomen began and grew steadily worse. It was paroxysmal at first but soon became steady and very severe. There was slight fever, no night sweats, about ten pounds loss in weight and much loss of strength. The appetite remained good.

Examination showed a pale, anæmic girl with a suspicious spot at the right apex but no active lesion, tenderness over both kidneys, especially the left, and some rigidity of the abdomen. The lower lumbar spine presented a tender prominence and X-ray showed a definite destructive and productive lesion of the fourth and fifth lumbar vertebræ.

Cystoscopic examination, July 29, 1920. Urethra inflamed. Instrumentation very painful. Bladder capacity 60 c.c. No residual. The mucosa of the fundus, and especially just back of the trigone, was severely inflamed. Few trabulations were noted. Mucus was marked. The right ureteral orifice was inflamed but normal in size and position, the left was even more inflamed. The vesical orifice was inflamed, cedematous and showed an irregular outline. Catheter passed on the right without obstruction and with slight trauma. Three minutes flow gave 15 c.c. of slightly bloody urine. Phenolsulphonephthalein appeared in six and one-half minutes and gave 8 per cent. in fifteen minutes. Microscopical examination showed pus and a few red blood cells. Tubercle bacilli were not found. Urea .2 per 100 c.c.

The left ureter was easily catheterized and yielded 5 c.c. in three minutes. The urine was hazy. There was no trauma. The dye appeared in three and one-half minutes and was 9 per cent. in fifteen. The urine contained pus, no red blood cells, gave urea .1, and showed the presence of tubercle bacilli. The total dye excreted in the first hour was 34 per cent., in the second 11 per cent., a total of 45 per cent. Advice was given against operation by the consultant because of the probable bilateral involvement. Bladder irrigations and instillations were tried without avail, as were various drugs. On August 24, another cystoscopy was done, showing an advancing process with ulcerations of the trigone and the left ureteral mouth. The right side showed no definite tubercular ulcerations. Left nephrectomy was advised even in the presence of presumed bilateral trouble, as the condition was getting desperate and the left kidney was definitely the worse. On August 27 the kidney and upper ureter were removed without difficulty. The upper pole showed a patch 3 cm. in diameter, mottled yellow with white spots, resembling tubercles. Microscopic examination showed tuberculosis of the kidney and ureter and also a minute papillary adenoma, benign in character.

There was a rather sharp reaction to the operation, but improvement slowly followed. The bladder symptoms were most distressing. The wound healed per primam but broke down later with slight serous discharge for many months. Spontaneous healing eventually occurred. The patient's general condition was miserable for about a year but slowly improved. The bladder is not yet clear but has markedly improved. The urine still contains considerable pus and mucus. Urination now is nearly normal in frequency at night and during most of the day. The patient now weighs more than ever, about 130 pounds, a gain from about 80 pounds at the worst. She works every day and aside from the long-persisting pain in the right side and occasional frequency of micturition, considers herself well.

This case was considered to be bilateral by all the consultants, but absolute proof is lacking. Even if it was not, recovery from such extensive and generalized tuberculous lesions is noteworthy. It reflects credit especially on the courage and "will to live" of the patient.

DR. ROBERT T. MORRIS said, regarding the infection of kidneys, ureters and bladder in a case in which the tubercle bacillus was not actually found, the speaker felt that perhaps a virulent colony of the colon bacillus might have been responsible. Sometimes this bacillus will act as a terminal infection after actual recovery from tuberculosis. Frequently colon bacillus invasion of the urinary tract is mistaken for tuberculosis and in that case is amenable

PERITHELIOMA OF THE CAROTID GLAND

to treatment with vaccines, urotropin and attention to the focus of colon bacillus invasion.

PERITHELIOMA OF THE CAROTID GLAND

DR. CHARLES E. FARR presented a woman, twenty-seven years of age, who entered the New York Hospital, June 13, 1923, and was discharged June 21, 1923. Her chief complaint was of loss of strength and of a swelling in the right side of the neck. This had been noticed three or four years, had grown slowly, was tender, sensitive to cold, but had caused no real anxiety. She felt weak, tired and run down.

The past history was negative. Her health had been good up to five years ago when she had her tonsils removed and her teeth cared for. She has had occasional gastric upsets. Her mother died of a carcinoma of the breast.

Physical examination revealed nothing abnormal save the swelling in the right side of the neck. This was 4×2 cm., rather lower than the top nodes of the deep chain, hard, slightly tender, attached deeply but not to the skin. It was considered a tuberculous node and operative removal was advised. Her general condition was fairly good, the lungs were clear both by clinical observation and the fluoroscope.

Operation was performed under nitrous oxid-ether anæsthesia, the growth being exposed by a transverse incision. It was found lying in the bifurcation of the common carotid and was at once recognized as a tumor of the carotid body. The mass was encapsulated but was strongly adherent to the sheaths of the internal and external carotids. Sharp dissection was necessary and considerable of the adventitia of the vessels was removed with the tumor. The grooves made by the vessels in the growth were well marked after removal.

Recovery from the operation was uneventful and the result has been excellent. The patient has recovered her strength and weight and feels as well as she ever did. She had a number of X-ray treatments by Doctor Remer, spent the summer at the shore and has been able to keep up her full duty as a nurse ever since.

The pathological report is as follows: The tumor mass is $3\frac{1}{2} \times 2 \times 2\frac{1}{2}$ cm. It is smooth, covered with a thin capsule and the cut surface shows a firm gray tissue with slightly softened centre. Frozen section shows the lesions of a perithelioma of the carotid gland. Examination by Doctor Stillman. Paraffin sections confirms the diagnosis of perithelioma. (Fig. 1.) "This name is objected to on the ground that the cells are not comparable to the so-called perithelial cells found in other structures. However, until the nature of the

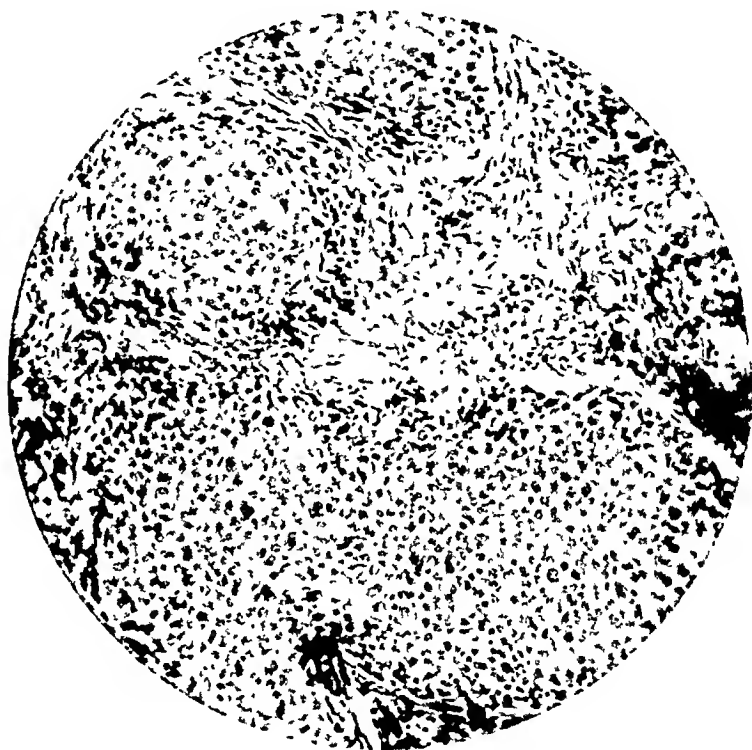


FIG. 1.—Perithelioma of carotid gland

gland is established, no definite opinion concerning the nature of the cells composing the tumor from the specific cells can be advanced. We therefore adhere to the original nomenclature." Report by Doctor Elser.

DR. JOHN DOUGLAS said that though few surgeons had sufficient experience with these cases to speak with authority, he had had one case which he reported ten years ago, in which, contrary to the statement that the rule in these cases is that they usually recur locally and sometimes but rarely metastasize, the patient was alive seven or eight years later with no sign of recurrence.

SARCOMA OF LEG

DR. CHARLES E. FARR presented a man, thirty-one years of age, a mechanic, who entered the New York Hospital, Cornell Division, service of Doctor Gibson, December 30, 1920, and was discharged January 24, 1921.

His chief complaint was of a bleeding mass in the right leg just above the ankle.

The present trouble began in 1911 when he sustained a compound fracture of the right tibia and fibula near the ankle. Before the wound healed a swelling was noted in the surrounding tissues and has continued to increase slowly ever since. The wound eventually healed but in 1915 it was crushed open between two barrels. He spent a month in hospital and again the wound healed. In 1918, he entered another hospital and the growth was excised. The wound healed but the growth was pronounced

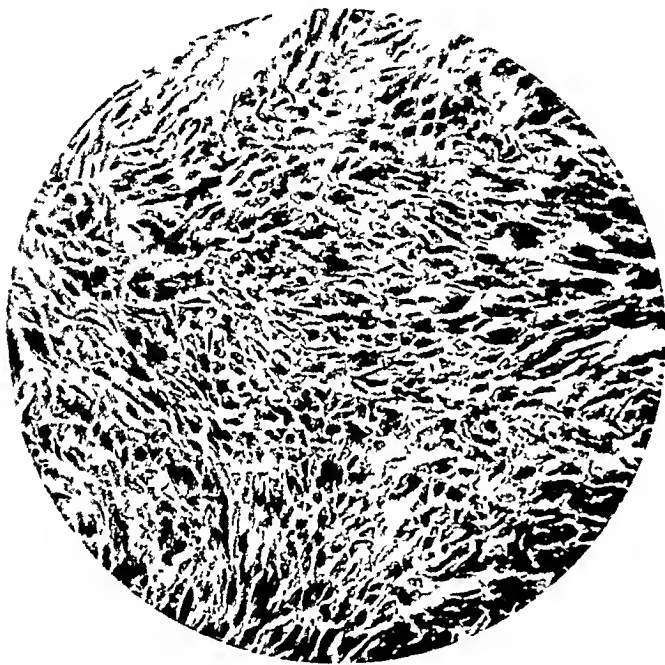


FIG 2 —Sarcoma of leg

growth promptly recurred in the margins. The growth was pronounced a myosarcoma.

One month before admission the mass again broke through the skin and this time began to bleed. Pain was intermittent, jumping and radiating to the great toe. The past history is negative except for a chancre at nineteen years of age, which was treated. There were no secondary manifestations. The family history is negative. Physical examination revealed a large, soft, fungous mass just above the right ankle extending well to the sides under the skin. There was an old operative scar and a bleeding mass of smooth red granulating tissue 5 cm. in diameter protruding from it. (Fig. 3.) The lateral masses are semifluctuant. There are a few enlarged nodes in each groin and in the axillæ. The patient was in excellent general condition with normal blood count and negative blood Wassermann on two occasions. He was put on a vigorous mixed treatment without benefit.

X-ray examination showed an old healed fracture of the tibia and fibula with a tumor in the soft parts, suggestive of periosteal sarcoma.

SARCOMA OF LEG

A biopsy was done January 1, 1921. "The growth is composed of closely packed spindle cells of medium size, showing a moderate number of mitotic figures. It is transversed by many irregular channels lined with endothelium, some of which contain blood. Diagnosis, spindle-cell sarcoma." (Fig. 2.)

On January 8, 1921, the leg was amputated above the knee. The specimen was described as follows: "There is a new growth on the ankle with skin absent in part. It is 5 cm. in diameter, raised 2 to 3 cm., and there are lateral masses the size of hen's eggs, with intact skin. On dissection the growths are located in the subcutaneous tissue. The growths on the side of the ankle are sharply demarcated and only loosely connected with the periosteum of the tibia. About 5 cm. above the growth is a thickening of the



FIG. 3.—Sarcoma of leg.

cortex, resembling an old callus. Microscopical sections of the tumor present the features of a spindle-cell sarcoma. The cells are of medium size. Blood sinuses are numerous."

The stump healed kindly, the post-operative reaction was mild. Two X-ray treatments were given before operation without apparent benefit. Three series of post-operative treatments were given in the succeeding three months, all in the inguinal region. What seemed a definite recurrence in the stump was noted during this time along with masses of enlarged nodes in the groins. No sections were made. Repeated examinations with radiograms at regular intervals since have failed to reveal any signs of recurrence or of metastasis. His general health is excellent.

The chief interest in this case, aside from its prolonged course and apparent cure, is in the speculation as to the source of the growth. It was generally considered in the hospital to be a periosteal spindle-cell tumor arising from the tibia, but a critical examination of the available data leaves an element of doubt.

DR. DOUGLAS SYMMERS (by invitation) said that he was impressed by Doctor Farr's statement concerning the duration of the patient's illness, the situation of the growths and their color, and he wondered if it might not represent a variety of sarcoma which had originated as a granuloma. He referred more particularly to the so-called multiple idiopathic hemorrhagic sarcomata of Kaposi, the clinical features of which reminded him of Doctor Farr's patient. He had had the opportunity to study several cases of this variety of disease, and recognized two histological types—one a chronic productive inflammatory or granulomatous lesion, the other a spindle-cell sarcoma.

SARCOMA OF UTERUS

DR. CHARLES E. FARR presented a woman, twenty-eight years of age, who entered the New York Hospital, July 26, 1920, and was discharged September 15, 1920, on the Cornell Division, service of Doctor Gibson. Her chief complaint was pain in the lower abdomen. This had lasted about a year, was worse on the right side, and recurred monthly with vomiting, constipation and fever. She had had a severe attack two days before admission.

There had been a previous admission to the service in 1917 with a similar history. Following a miscarriage there was a moderate leucorrhœa. For this a curettement was done and lacerations of the pelvic floor repaired. Under the anæsthetic the uterus was noted as slightly enlarged, the fornices were

negative. Recovery was uneventful and the patient remained in good health until the second admission. She had had previously two healthy children. Her family and past history were negative.

Physical examination on the second admission failed to reveal anything noteworthy except moderate tenderness in the lower abdomen and also rather marked tenderness in the fornices.

Laparotomy was done July 26, 1920. There were a number of small subperitoneal and mural fibroids, the largest 2 cm. in diameter. This latter was mural and was removed with more than the

usual difficulty in doing a simple myomectomy. The tubes and ovaries were normal, the appendix mildly inflamed. It was removed. The gall-bladder was also inflamed and full of calculi and it was removed. Recovery from the operation was uneventful.

The pathological report on the larger tumor mass was as follows: "A small fibroid tumor, 2 x 1 x 1 cm. and another the size of a French pea. Microscopical examination of a frozen section shows a very cellular myoma of the uterus with evidences of a turbulent proliferation of the cells. Giant cells with single and multiple giant nuclei indicate sarcomatous transformation. Whether the growth shows invasive properties cannot be decided from the section. Grossly the tumors appear well circumscribed. The appendix is involutinal. The gall-bladder shows chronic inflammation and contains 30 yellowish-white faceted stones. There is marked atrophy of the mucosa and muscularis."

After consultation with Doctor Elser it was deemed wiser to remove the uterus and this was done, August 19, 1920, the tubes and ovaries along with the uterus to the cervical stump being ablated. Nothing abnormal was noted either grossly or microscopically save a tiny fibromyoma near the cervix.

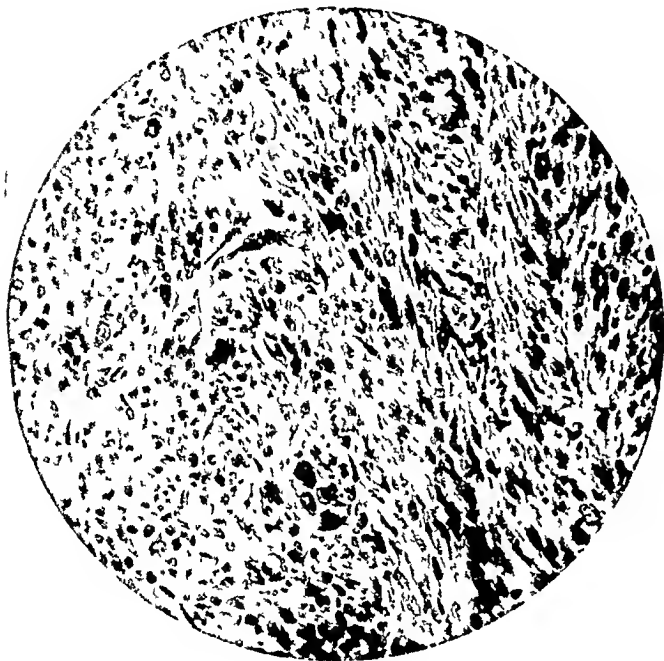


FIG. 4.—Sarcoma of uterus.

CURE OF FLAIL SHOULDER BY ANKYLOSING SHOULDER JOINT

A broad band of hyalinized connective tissue near the surface was considered a part of the original tumor capsule. In it are several small foci of foreign body giant cells, but no evidence of new growth. The ovaries showed a number of small cysts containing clear fluid and a few with bloody gelatinous material.

Again recovery was uneventful. A series of X-ray treatments were given and the patient has been well ever since, except for mild menopause symptoms. In January, 1921, there were mild gastric symptoms and a small filling defect on the lesser curvature pre-pyloric, but she improved under simple remedies. In June, 1921, she was again operated upon for a femoral hernia. The inguinal ring was also opened and an exploration of the pelvis revealed nothing abnormal.

Repeated microscopical examinations of paraffin sections confirm the diagnosis of leiomyosarcoma. (Fig. 4.)

CURE OF FLAIL SHOULDER BY ANKYLOSING THE SHOULDER JOINT

DR. H. H. M. LYLE presented an ex-soldier who was wounded at Ypres in September, 1918. He sustained a shell wound of the right shoulder with paralysis of the circumflex nerve. After a series of operations extending over more than five years, the arm hangs by his side and he cannot abduct it more than 10°. He entered St. Luke's Hospital, December 15, 1923, and was operated on four days later; an ankylosis of the shoulder joint being performed and the arm fixed in plaster. The arm was abducted to about 60° with the elbow joint in front of the corneal plane, so that the middle finger of the hand would reach the centre of the opposite clavicle; the cast was removed at the end of eighty days.

The X-ray of the shoulder before operation shows the acromion, coracoid and the outer portion of the spine of the scapula missing—a free fragment of bone represents what is left of the acromion—this was used as a wedge in the ankylosing operation. The functional result is excellent. He can comb his back hair, fix his collar button and reach into his hip pocket.

The main object in presenting this case is to show how useful a good ankylosis of the shoulder is. Here is a man who has undergone a nerve operation, a transplantation of a portion of his trapezius, two bone grafts, an arthrodesis and two other unknown procedures. It is perfectly obvious that from the first an ankylosis of the shoulder should have been performed, this would have saved these useless operations. It is a well-known fact that arthrodesis of the shoulder often fails. A bony fixation in good position gives excellent functional results within a few months. An arthrodesis should not be attempted in the face of an extensive bony destruction or where the deltoid or the muscles attached to the tuberosities are damaged or paralyzed, or where strength rather than mobility is desired.

He was led to emphasize these points by the fact that it had been his misfortune to examine a number of veterans who at the end of five years have useless arms, victims of ill-advised bone grafting, arthrodesis and muscle transplantation.

DR. ROYAL WHITMAN said that his experience had been practically confined to paralysis in childhood. In the class in which it was difficult to assure firm ankylosis, the arm was usually brought to a right angle with the scapula in order that the acromion might be embedded in the head for greater security.

INJURY TO SHOULDER JOINT

DR. H. H. M. LYLE presented also a case of shell wound of the shoulder with partial destruction and dislocation of the head of the humerus, with the formation of a new joint between the head of the humerus and lower edge of the glenoid, complicated by fibrous ankylosis of all the finger joints, due to prolonged immobilization.

This man entered St. Luke's Hospital, July 10, 1923, with a history that while serving with the 27th Division in September, 1918, he was wounded in the right shoulder. He has had twelve operations in all. The X-ray shows that the deformed and dislocated head has formed a new joint on the lower border of the glenoid. Compare for a moment the functional ability of this patient's arm with that of the one with the ankylosis. The maximum abduction is 20 per cent. and he cannot abduct against resistance; in other words, the only value of this arm lies in the forearm and hand. Fortunately this man is a clerk and does not need much power.

When he came to the hospital all the finger joints were ankylosed in a position of extension, and it was impossible for him to grasp. The right hand presents fibrous ankylosis of all the metacarpal and phalangeal joints with the exception of the thumb; the extensor tendon had undergone adaptive shortening. He had had a thorough course of physiotherapy without improvement. At the end of ten months' further treatment he now has a perfect grasp and motion in all joints with the exception of the terminal joint of the little finger. He was treated by the method of gradual flexion and wedging as previously demonstrated before this Society.

OSTEO-CHONDRITIS OF PATELLA

DR. ALEXIS MOSCHCOWITZ presented a woman, who was admitted to Mt. Sinai Hospital, November 19, 1923, complaining of swelling and disability of the left knee-joint which had lasted four weeks. She stated that approximately six years ago she felt the left knee-joint give way; following this she experienced pain for several weeks with some enlargement of the joint. Her present illness dates back about two weeks and began suddenly while dancing, when she felt again the left knee give way and she was unable to support herself upon it; there never was a definite locking of the joint. Since that time the knee-joint has been stiff and swollen with inability to flex the joint beyond 120 degrees. Physical examination showed that the circumference of the left knee-joint was about $1\frac{1}{2}$ inches larger than the right. X-ray examination did not show anything very definite to account for the condition. Under conservative treatment there was absolutely no improvement in the condition. Under these circumstances it was decided to operate on the patient, with a provisional diagnosis of dislocation of the internal semilunar cartilage.

Operation, November 27—gas and ether anæsthesia. An incision $4\frac{1}{2}$ inches in length was made parallel to the inner border of the patella. Inspection revealed the semilunar cartilage to be intact and in place.

The patella was now rotated in order to expose the cartilaginous surface. When this was done there was to be seen projecting from its under surface a small cartilaginous mass of tissue, free at its upper end but still attached at its lower margin, where it merged with the underlying bone. It was about the size of the end of a nail and formed an angle of 30 inches with the cartilaginous surface of the patella. This projecting piece of cartilage was excised. The joint was closed in layers. Primary union resulted. Gentle active and passive motions were instituted about eight days after operation.

BILIARY FISTULA OF VERY LONG DURATION

She was discharged from the hospital, December 23, 1923, at which time the patient could flex her leg voluntarily beyond a right angle, without pain. Since her discharge the improvement has continued and she is now absolutely normal in every respect. On reëxamining the plates after operation there was to be seen a slight projection on the posterior surface of the patella and there is no doubt that it corresponds to the pathological findings found at the operation.

BILIARY FISTULA OF VERY LONG DURATION

DR. ALEXIS V. MOSCHCOWITZ presented a woman, forty-six years of age, who was referred to him in December, 1921, with typical attacks of cholelithiasis, for the relief of which he performed cholecystectomy, December 22, 1921. It is important to note that contrary to Doctor Moschcowitz' custom he extirpated the gall-bladder in this case from above downward. The operation was unusually easy, the entire period consumed being just 35 minutes. The specimen consisted of the gall-bladder cut across at the cystic duct and contained two very large calculi and a number of small ones. On the tenth day after operation the patient developed a biliary fistula, and at no time after the formation of the biliary fistula was there any bile present in the fæces. At about this time also during one of the dressings, as the wound was being irrigated, a slough about 1½ inches in length was discharged from the wound. This tissue may have been the duct, but it was too degenerated to be recognizable.

For the next month all the bile continued to discharge through the fistula. As no progress was made, a second operation was done for the closure of the biliary fistula February 2, 1922. Owing to unusually dense adhesions, the exposure was very difficult. After considerable search the hepatic duct was recognized practically at the portal fissure. Only a minimal piece was left for the subsequent manipulations. No amount of search, even after complete mobilization of the duodenum, revealed any trace of the common duct. The search for this structure was abandoned after three hours. The operation was therefore finished in the following manner. A rubber tube was threaded into the stump of the hepatic duct. A small opening was made into the duodenum and the tube introduced. The duodenum was next sutured to the stump of the hepatic duct and the entire suture line surrounded by omentum. The wound was closed, but drained by a massive rubber dam packing.

No bile leaked for the first week. Then again a biliary fistula formed which in the course of a few days again became complete. Patient was discharged with a complete biliary fistula two and one-half months afterwards.

She was seen again in June, 1923, at which time the fistula was complete and not even a trace of bile was present in the stool. Barring the presence of the biliary fistula, which quite naturally required frequent dressings, the patient was perfectly well and had gained a great deal in weight and strength.

About a week after her last visit she noticed for the first time in two years some color in the fæces. About one week after that the wound closed and has remained healed since that time.

An X-ray taken recently showed no trace of the tube which was implanted at the hepatico-duodenostomy.

There are several notable points about this case: (1) The formation of a complete biliary fistula after a simple cholecystectomy, without any injury whatsoever to the common duct. (2) Perfect health and digestion in the presence of a complete biliary fistula. (3) The long duration of the fistula. (4) Spontaneous closure of the fistula.

DR. ALLEN O. WHIPPLE reported some cases of biliary fistula that, although they did not close spontaneously, he considered interesting in comparison with the one Doctor Moschcowitz presented. The operations were also entirely uncomplicated and very simple, and in one the gall-bladder had been removed from the fundus down to the cystic duct, and in the other the cystic duct had been carefully severed and ligated. In both cases a biliary fistula developed and existed, one for three months and in the other for seven weeks, and a second operation was done. Careful dissection was done in attempting to find the common duct and the gastrohepatic omentum was dissected without finding any evidence of any duct. In one of these cases it was thought that occasionally bile was present in the stools. This fistula was opened and a probe was passed which did not seem to go into the duodenum. In one case death resulted in two years from cholemia and the other patient was lost sight of. Both were uncomplicated cholecystectomies. In the dissections no remains of the common duct could be found. Both were drained cases and in one a rubber tube was used, which it was thought might have impinged on the gastrohepatic omentum, causing connective-tissue displacement of the common duct.

DR. JOHN DOUGLAS said that although he had no explanation for Doctor Moschcowitz' case, he did think it well to emphasize the fact that these fistulae can happen without any division of the common duct at the time of operation. This should be emphasized so that when a surgeon is sued for the development of a biliary fistula he can point to the records showing that men of such ability as Doctor Moschcowitz and Doctor Whipple have had similar experience. In a case of his own a very severe infection followed a cholecystectomy and resulted in actual destruction of part of the duct which had been drained. There was increasing jaundice and the patient developed stenosis of the common duct. Secondary operation showed destruction of about 1 cm. of the common duct, which was dissected out and brought end-to-end. The patient was shown before the Surgical Society as cured, but came back again deeply jaundiced and with no bile in the stools, which later cleared up, but every two or three months she now has attacks of jaundice. This was from a secondary infection and not from injury at the time of operation, and the speaker believed that the fact that this occurred should be put on record.

DERMOID CYST OF TONGUE

DR. ALEXIS V. MOSCHCOWITZ presented a woman, twenty-one years of age, who was admitted to his service at Mt. Sinai Hospital, December 4, 1923. Her history dates back to the very earliest childhood, when she first noticed that her tongue became swollen so that she could not talk or swallow. At the age of eight the swelling ruptured spontaneously and discharged pus through the mouth. Since that time the patient had been operated upon six times at varying intervals, most of the incisions being external incisions parallel with the lower jaw. After the last operation a drainage tube was kept in for six months and the patient was advised to inject boric acid solution through the tube. On one such occasion she noticed that the injected fluid

LYMPHOID HYPERPLASIA OF THE APPENDIX IN CHILDREN

escaped through the mouth and she could repeat this performance at will. Upon removal of the tube, however, the wound healed up promptly. Since that time there occurred very frequently a reopening of the neck wound with a discharge of pus for a few days.

When she entered the hospital the physical examination presented the following local condition. There was a broad transverse scar, the seat of a keloid, situated more on the left side than on the right. There was no fluctuation and no discharge from the scar. The tongue protrudes normally in the midline. On its upper surface midway between the tip and line of the circumvallate papillæ, directly in the midline, there is a small excrescence into which a very fine probe can be made to enter for a distance of about one centimetre. There was no discharge from this sinus. An attempt was made to inject the sinus with bismuth and to X-ray the same. This attempt was however unsuccessful. In view of the long history of the case, a pre-operative diagnosis of dermoid cyst of the tongue was made.

December 10, operation in gas and ether anæsthesia. An incision four inches in length was made on the under surface of the chin, excising all the old scar. A probe was inserted into the sinus on the dorsum of the tongue. The mylohyoid muscle as well as the underlying hyoglossus, geniohyoglossus and genioglossus were divided transversely. With considerable difficulty the probe introduced from the dorsum of the tongue was located in the midline. The right lingual artery was ligated. The entire tract extending from the floor of the mouth to the opening on the dorsum of the tongue was excised *en masse*, finally excising a small piece of the mucous membrane of the tongue. This was sutured with plain catgut and all of the muscles sutured together as well as possible with interrupted sutures, drainage by means of small piece of rubber dam. Uneventful recovery followed and patient was discharged healed December 28, 1923.

The excised specimen contained in the mid-portion a small cyst filled with sebaceous material and hair. Pathological report by Doctor Mandlebaum confirmed the diagnosed of dermoid cyst.

Cases of dermoid cyst of the tongue are exceedingly rare, so rare indeed that very few cases have been reported in medical literature. He had requested his adjunct surgeon, Doctor Colp, to publish this case in conjunction with other published cases.

LYMPHOID HYPERPLASIA OF THE APPENDIX IN CHILDREN. ITS RELATION TO RECURRENT APPENDICITIS

DR. THOMAS A. SMITH read a paper with the above title, for which see ANNALS OF SURGERY, 1924, vol. lxxix, p. 871.

DR. DOUGLAS SYMMERS (by invitation) said that he had seen lymphoid hyperplasia of the appendix in three grades. The first is characterized by simple hyperplasia of the follicles, and removal of the appendix is followed by disappearance of symptoms. If the appendix in these circumstances is left in the body, the lymphoid hyperplasia subsides and then recurs, and, after a number of such attacks, becomes associated with sclerosis of the connective tissues as a result of mechanical reaction to increase in the size of the follicles. Finally, the connective tissue of the appendix completely replaces the structures of the mucous membrane and the lumen becomes obliterated. This latter change is found most frequently in older children or young adults, and represents a replacement fibrosis and not an inflammatory lesion. His experience with

these three types of lymphoid hyperplasia of the appendix, both clinically and at autopsy, led him to believe that the condition was a part of status lymphaticus, which condition, however, does not necessarily constitute a contra-indication to operation, in spite of the fact that there is a widespread impression that subjects of status lymphaticus frequently die suddenly under apparently trivial provocation. As a matter of fact, about one out of every ten persons is a subject of status lymphaticus and sudden death among them is a rarity. When it does occur, however, the circumstances are so dramatic as to create a profound impression and to exaggerate the dangers that attend this type of individual.

DR. ROBERT T. MORRIS said that when Doctor Symmers' paper on "Lymphoid Hyperplasia of the Appendix" was published, he looked into the matter and found that some of the cases which he had previously described as fatty degeneration of the appendix and as fibroid involution doubtless belonged in the lymphoid hyperplasia group. Degenerative lesions in the germinal areas would lead to fatty changes and connective-tissue hyperplasia might follow. The speaker believed that pain referable to the appendix in lymphoid hyperplasia was due to the swelling of soft tissues of the appendix within the constricted container of peritoneum.

Chronic appendicitis may be classified pretty well under four categories. There is one infective lesion and three irritative lesions. Low-grade infection with little tendency to acute phases was not the most common form of chronic appendicitis. The most frequent chronic form was the irritative involution lesion, not infective, with or without lymphoid hyperplasia. Appendix symptoms here were due to inclusion of nerve filaments remaining in contracting connective tissue.

Another irritative lesion, congestive in its nature related to disturbances of circulation in connection with cases of relaxed peritoneal supports. A third irritative lesion included lymphoid hyperplasia. All four kinds of chronic appendicitis give symptoms that are much alike. There is tenderness on deep pressure a couple of inches to the right of the navel and a little below, corresponding to the site of the fused ganglion of the lumbar sympathetic system. Tenderness on deep pressure over the appendix itself at McBurney's point, on the other hand, related to acute infective lesions of the appendix.

Briefly in all forms of chronic appendicitis the fused ganglion is hypersensitive on pressure, but in all forms of acute appendicitis the appendix itself is hypersensitive on deep pressure.

PREVENTION OF POST-OPERATIVE BLEEDING AFTER BLOODLESS OPERATIONS

DR. THEODORE DUNHAM said that when using the procedure he was about to describe, he did not, at the conclusion of the operation, remove the constricting rubber bandage. Small vessels and bleeding points he did not seek out, ligating or twisting off only evident vessels. This saves time and reduces or eliminates the placing of ligature material in the wound. Any required

PREVENTION OF POST-OPERATIVE BLEEDING

drains are now placed and the wound is sutured; the appropriate dressing is applied and secured with bandages or otherwise. All the foregoing is done while the operation region is still bloodless. At this point apply an exceedingly snug bandage of gauze or muslin over the completed dressing. Only after this very snug enveloping bandage has been applied is the rubber constricting bandage removed. In spite of the tight enveloping bandage, some blood will percolate through the tissues and the toes or fingers will regain color. The tight bandage is left in place for two or three hours and then removed. The removal of this bandage does not disturb the dressing or the wound beneath it. They are simply relieved of the unusual pressure.

At the dressing of wounds so managed, he finds little oozing into the dressings and the wounds dry. The merits of this procedure are saving of time in operation and the saving of blood. He had used it in appropriate cases for over thirty years, in operations varying in magnitude up to resection of the knee and had thus far met no drawback. He did not advocate this method as a cloak for carelessness in hæmostasis, but to save the loss of blood and loss of time ordinarily consumed in caring for tiny vessels and the parenchymatous oozing which follows the removal of a constricting rubber bandage.

CORRESPONDENCE

NATURE'S CURE OF CHOLECYSTITIS

EDITOR ANNALS OF SURGERY:

Sir:

Since I have adopted the practice, when opening the abdomen for any specific lesion, to make a parietal incision large enough to permit the exploration of the whole peritoneal cavity, I have been amply rewarded by the number of unexpected things found. Occasionally I have met with what seemed at first to be the absence of a gall-bladder, but on further examination have always found a small contracted mass deeply attached and densely adherent to the under surface of the liver in the region of the foramen of Winslow, which proved to be a greatly contracted gall-bladder the coats of which had undergone such fibrotic thickening that showed that there had been at some time an acute or continued infection which had resulted practically in the destruction of the organ. About once in every fifty cases of operation for gall-stones in which a history of many previous attacks may be elicited, I have found a similar condition with one or more gall-stones out of sight and often out of reach, embedded in a shrivelled up, deeply placed and deeply adherent sac. In some of these cases, calculi have been found co-existing in the hepatic ducts. It is often the case that these conditions are found in patients who are bad subjects for any operation, much more so for one in the depth of the upper abdomen. The conditions are such as to warn the prudent surgeon to abandon all thought of cholecystectomy and to content himself with simply opening the contracted fibrotic sac and removing any calculi present, after which, aided by traction upon the thick fibrous-walled bladder, making a further search for calculi in the ducts. If any are found in the hepatic ducts or high up in the common duct, they may be milked down by the surgeon's fingers into the terminal common duct where the duct may be incised and the calculi shelled out. The wound in the common duct need not be sutured—a wisp of silkworm gut, doubled and tied near the ends, is placed near the opening for drainage, but may be dispensed with within a week as a rule owing to the rapid healing of the wound. The cavity of the contracted gall-bladder is also purposely left wide open with a similar wisp of silkworm gut left in place for drainage.

My advocacy of this manner of treating an exceptional condition of the gall-bladder, will not be interpreted as in any way inconsistent with my advocacy for years of cholecystectomy as the best treatment in general for cholecystitis.

JOHN O'CONOR, M.D.,

Buenos Aires, Argentina.

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ARTERIOVENOUS ANEURISM

CLINICAL EVIDENCE CORRELATING SIZE OF FISTULA WITH CHANGES IN THE
HEART AND PROXIMAL VESSELS

BY EMILE HOLMAN, M.D.

OF CLEVELAND, OHIO.

FORMER RESIDENT SURGEON, PETER BENT BRIGHAM HOSPITAL, BOSTON, MASS.
FROM THE SURGICAL SERVICE OF HARVEY CUSHING

IN A "Memoire sur les aneurysmes,"¹ read before the Royal Academy of Sciences, Paris, in 1832, Gilbert Breschet wrote as follows with reference to the changes noted in the vessels proximal to an arteriovenous fistula:

"It is necessary that the wound of the artery should be of a certain size, and that it be made in a direction to bring about the production of an opening constantly wide open and in direct contact with that of the vein. The works of Jones, of J. Bell, of Beclard, of Guthrie, and our own experiences in wounds of the vascular system, demonstrate that the kind of instrument that wounds the artery, the direction and extent of the wound made in the walls of this vessel, are not indifferent circumstances in connection with the results of the traumatic lesion, for according as the wound of the artery is parallel or perpendicular to the axis of the vessel, and especially according as the transverse wound is of greater or less extent, there results from it a simple fissure or a rounded opening constantly gaping, and consequently this wound will become cicatrized or will give place to a varicose aneurism, and the latter will permit, more or less freely, *the entrance of the venous blood into the artery.*"² The dilatation of the brachial artery above the wound of this vessel and its flexuosity was observed by W. Hunter and considered by him as an effect of the afflux of a larger quantity of blood into this artery because part of the blood which it contained was introduced into the vein. This does not appear to us to be sufficient reason nor in harmony with physical laws. These changes in the condition of the vessel appear to us rather *to result from the passage of a small quantity of black blood into the artery by the traumatic opening,*² the dilatation and increase in length of the artery not being limited precisely to that part of the canal situated below the wound."

Breschet's reasons for the changes in the blood-vessels (as indicated in the italicized lines) seem rather fanciful to us to-day, but there is both clinical and experimental evidence that he was correct in his assumption that "the direction and extent of the wound made in the walls of the artery are not indifferent circumstances in connection with the results of the traumatic lesion."

Experimentally, the intimate relationship between circulatory changes and

¹ Memoire sur les aneurysmes, Gilbert Breschet, Mem. de l'Acad. roy. de med. Paris, 1833, vol. iii, p. 101.

² The italics are the author's.

arteriovenous fistula has been definitely established.³ Hearts which have dilated in response to the formation of a fistula have again subsided following the elimination of the fistula. Vessels proximal to the fistula have enlarged following its formation and contracted after its excision or closure. Though contrary to the view expressed by Lewis and Drury,⁴ if I understand them correctly, there is also experimental evidence to show that the hydraulic principles normally concerned in the maintenance of blood-pressure in the

circulatory system also function in the presence of a fistula, and that the cardiac enlargement and dilatation of the proximal vessels can be explained on purely mechanical and physical grounds. The area of lowered resistance introduced into the circulatory system by the fistula results in the establishment of two routes for the passage of blood (Fig. 1): (1) through the normal capillary bed back to the heart, and (2) through the fistula back to the heart. It is in accordance with physical laws that a greater volume of blood will be directed toward the fistula with its minimal resistance than toward the capillary bed, and it is this greater column of blood flowing toward and through the fistula that produces the dilatation of the vessels leading to and from the fistula. The greater volume of blood flowing through the fistula per unit of time must necessarily

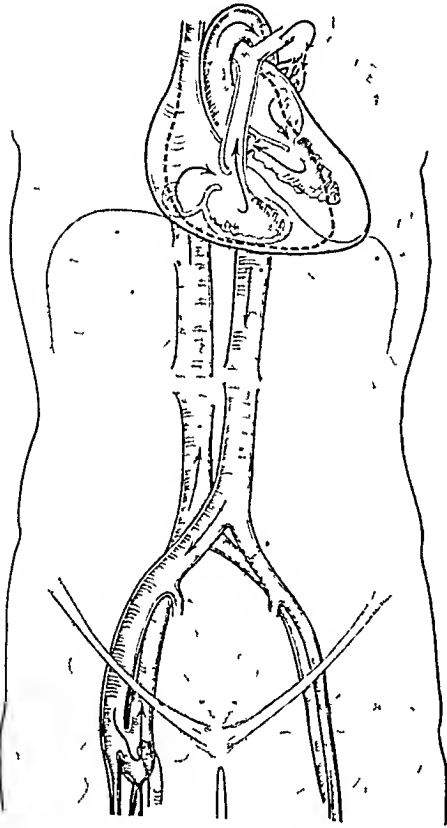


FIG. 1.—Schema of circulation in a case of a right femoral fistula (Charles Mundi). Dilatation of that portion of circulatory system represented by heart-artery-fistula vein. Dotted line shows cardiac area two months after excision of fistula

pass through the heart, and just as the vessels place themselves in harmony with the volume of blood passing through them, so the heart will dilate to accommodate the increased flow per unit of time through its chambers.

Obviously, the amount of blood which will be short-circuited through the fistula back to the heart depends upon the size of the opening and upon the unobstructed return flow to the heart. Experimentally, small fistulae produced very minor changes, and tended to heal spontaneously, whereas large fistulae resulted invariably in a dilatation of the vessels and heart due to the

³ Experimental Studies in Arteriovenous Fistula by Emile Holman, *Archives of Surgery*, Nov., 1924, vol. ix, pp 822-879.

⁴ Observations Relating to Arteriovenous Aneurism, T. Lewis and A. N. Drury, "Heart," vol. x, No 4, Oct, 1923, pp 301-389.

increased volume flow through them. This dilatation is progressive and will continue until the resistance offered by the fistula, plus the resistance to any further dilatation of the vessel leading to it, equals the resistance which exists in the capillary bed elsewhere. When this equalization of resistances in the two systems is reached, there will be no further increase in the volume of blood flowing toward and through the fistula, and consequently that part of the circulatory system through which this short-circuited blood must pass will undergo no further dilatation. Numerous cases are recorded in the literature which have apparently reached an equilibrium, the one of longest standing being a temporal fistula of 36 years' duration.⁵

It was shown experimentally that this increasing volume flow through the fistula is accompanied by an increase in total blood volume as one of the compensating adjustments for the short-circuited blood flow. This is a necessary adjustment if general blood-pressure is to be maintained at a level compatible with life in the face of the marked fall in peripheral resistance introduced by the fistula.

As clinical evidence of the intimate relationship between the size of the fistula and the development of circulatory changes, the following case is presented:

Charles Mundi, aged forty-two, a most coöperative patient, first entered Doctor Cushing's service at the Peter Bent Brigham Hospital in November, 1921, Surgical No. 15706, when the diagnosis of a spastic paraplegia from spinal sclerosis was made, associated with an arteriovenous aneurism of the right femoral vessels. He was discharged untreated. He reëntered the hospital on September 24, 1923, at Doctor Cushing's request in order that we might observe the progress of his malady. The question had arisen as to what association, if any, existed between the fistula and the spinal sclerosis, and on the assumption that such an interrelationship might possibly exist, he was again studied with reference to the advisability of eliminating the fistula by operation.

Clinical History.—The following relevant facts were obtained as to the development of a slowly progressive general weakness which apparently, but not certainly, followed in the wake of the arteriovenous fistula of the femoral vessels.

At the age of twelve he had typhoid fever, accompanied by a temporary swelling of the right leg. When a student at college at the age of sixteen, he was one day cleaning a rifle, with the barrel resting in his right groin. The rifle was accidentally discharged, the bullet passing through his upper thigh and emerging from the buttock. There was momentary profuse bleeding, controlled, however, with no great difficulty by local pressure. The wound healed per primam, but he was compelled to remain in bed for almost two months because of extreme weakness. During the first few days his right leg swelled to enormous proportions. At one time his right ankle measured 17 inches in circumference. This swelling then gradually receded and had practically subsided when he returned to school two months after the accident. This great swelling below an arteriovenous aneurism has been an invariable occurrence, experimentally, following the formation of large femoral and iliac fistulæ. The gradual subsidence within 8 to 10 weeks was also noted in our experimental animals. He does not remember the time of onset of the thrill, but it was detected neither by the doctor nor by himself while he lay in bed. He believes it came on within several months after the accident, but as it seemed to give him no trouble he paid no further attention to it.

⁵ C. H. Moore: An Account of a Case of Arteriovenous Aneurism of the Temporal Vessels. Med. Chir. Jr., London, 1858, vol. xli, p. 1.

Several years later, from 1907 to 1911, he served as a deputy sheriff in the Canadian Northwest, most of his time being spent on horseback. While in Alberta he sustained gunshot wounds of the left arm and later of the right arm, neither injury giving him any permanent trouble. Ever long he began to notice a slight weakness of the right leg, which hindered him in mounting the saddle. This weakness finally forced him to quit his post in Canada, and he returned to Boston, where he worked as a clerk in a store,

still actively on his feet. His general health began to fail, however, and hoping to regain his strength in the open air, he bought a farm. The change proved of little value, his disability progressed, and there developed sudden attacks—unaccompanied by loss of consciousness—in which both legs seemed to give way, causing him to fall to his knees. A few minutes of rest would enable him to go on.

Since 1914, there has been a slowly progressive increase in his malady. The general weakness progressed, until it involved both legs and both arms, and on admission he could barely get about with the use of a cane. His right leg became quite useless, subject to spasmodic twitching and contractions at the knee and hip which were entirely uncontrollable. There had also developed in the past few years an annoying inability to retain his urine, accompanied by a marked frequency.

Physical Examination.—On physical examination the patient presented two presumably unrelated maladies, one of the nervous system, the other of the cardiovascular system. Briefly, the important neurological observations were a markedly impaired general muscular strength, evident atrophy of the interossei muscles, and of the thenar and hypothenar eminences on both sides, a marked spasticity of the lower extremities most



FIG 2—Photograph of patient before operation to show (black lines) the comparative sizes of the two femoral vessels just below Poupart's ligament; also the large vein just above the pubis, and the differences in the size of the two legs, particularly below the knee

marked on the right, with a bilateral inexhaustible ankle clonus, hyperactive knee kicks, and a positive Babinski response on the right. There was noted on one occasion fibrillary twitching of the pectoral muscles, and frequent spasmodic uncontrolled movements of the right leg were constantly present, these movements consisting of flexion of 30° at the hip and knee, and dorsal flexion of the foot and big toe. There were no sensory changes, and no ataxia, nor nystagmus.

Cardiovascular System—The fistula and its dependent vascular phenomena presented the main points of interest. In the right groin about $2\frac{1}{2}$ cm. below the middle of Poupart's ligament was a short scar marking the site of the wound of entrance. There was an evident fulness in Scarpa's triangle, and on palpation over this area the

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characteristic thrill of an arteriovenous fistula, continuous throughout the cardiac cycle, but intensified during systole could be felt. This thrill was diffusely palpable over an area just larger than the flat of one's hand, its point of greatest intensity being 2 cm. below and 2 cm. medial to the midpoint of Poupart's ligament. On auscultation over the point of greatest thrill a deafening bruit was heard, which could be followed along the proximal vessels to a point above the umbilicus and along the distal vessels to the ankle. The thrill and bruit disappeared completely on digital compression over the point of greatest intensity, which presumably obliterated the communication between the two vessels.

On palpation the iliac and femoral vessels felt greatly enlarged up to the point of greatest thrill, where there was a sudden reduction in the size and "lift" of the artery. The femoral artery just below Poupart's ligament felt about 2 cm. in diameter on the right and hardly half that size on the left (Fig. 2). Blood-pressure readings in the left leg were recorded as 140/58, in the right leg 124/50. Blood-pressure in the left arm varied from 110/56 to 120/58. The pulsation in the popliteal, posterior tibial, and dorsalis pedis arteries could just be felt on the right, though readily palpable on the left. There was a markedly prominent vein in the abdominal wall just above the pubis. With the right leg elevated at right angles to the body and the artery in the groin closed by compression, the toes retained their normal pink color after 5 or 6 minutes or as long as the femoral artery remained closed, indicating an excellent collateral circulation.

On palpation the greatly enlarged proximal artery could be followed to the bifurcation of the aorta, where the right common iliac seemed at least twice as large as the left. An apparently enlarged abdominal aorta could be easily palpated. The liver descended 5 cm. below the costal margin on inspiration, but did not pulsate.

The cardiac impulse was quite prominent in the fifth interspace, 2 cm. outside the nipple line. At the level of the fourth rib, the heart measured 11.5 cm. by 3½ cm. The cardiac area had apparently increased about three centimetres in width since the examination on his first admission two years previously. There was no shock nor thrill present over the cardiac area, but on auscultation a distinct systolic murmur was heard over the entire precordium.

Laboratory examinations revealed a negative Wassermann reaction in blood and spinal fluid. Red blood-cells, 4,750,000; hæmoglobin, 110 per cent. (Sahli); white blood cells, 9000; urine negative.

A variety of special tests were made:

(A) *Effects on Circulation Produced by Closing the Fistula.*—On closing and opening the fistula, startling changes in blood-pressure and pulse occurred (Fig. 3). These fluctuations in blood-pressure and pulse were recorded by means of a modified Erlanger

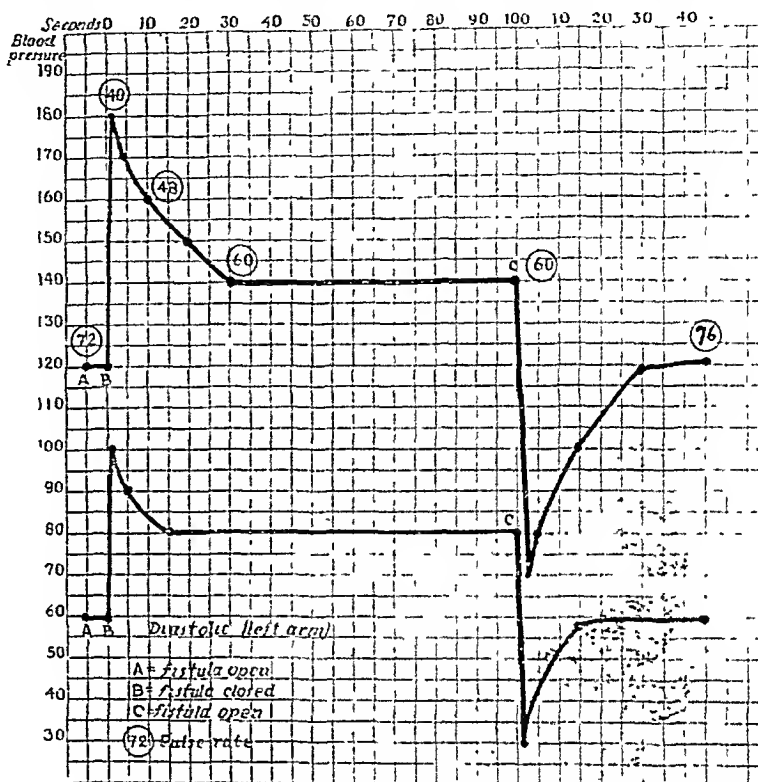


FIG. 3.—Fluctuations in blood-pressure (left arm) on opening and closing femoral fistula, accompanied by variations in pulse rate.

apparatus⁶ employed in the experimental laboratory. The normal systolic pressure in the left arm was 116 to 120. Closing the fistula caused an immediate increase in systolic pressure to 180 for two beats only, after which it fell rapidly and steadily to 140, where it remained as long as the fistula was closed (Fig. 4). Changes in diastolic pressure

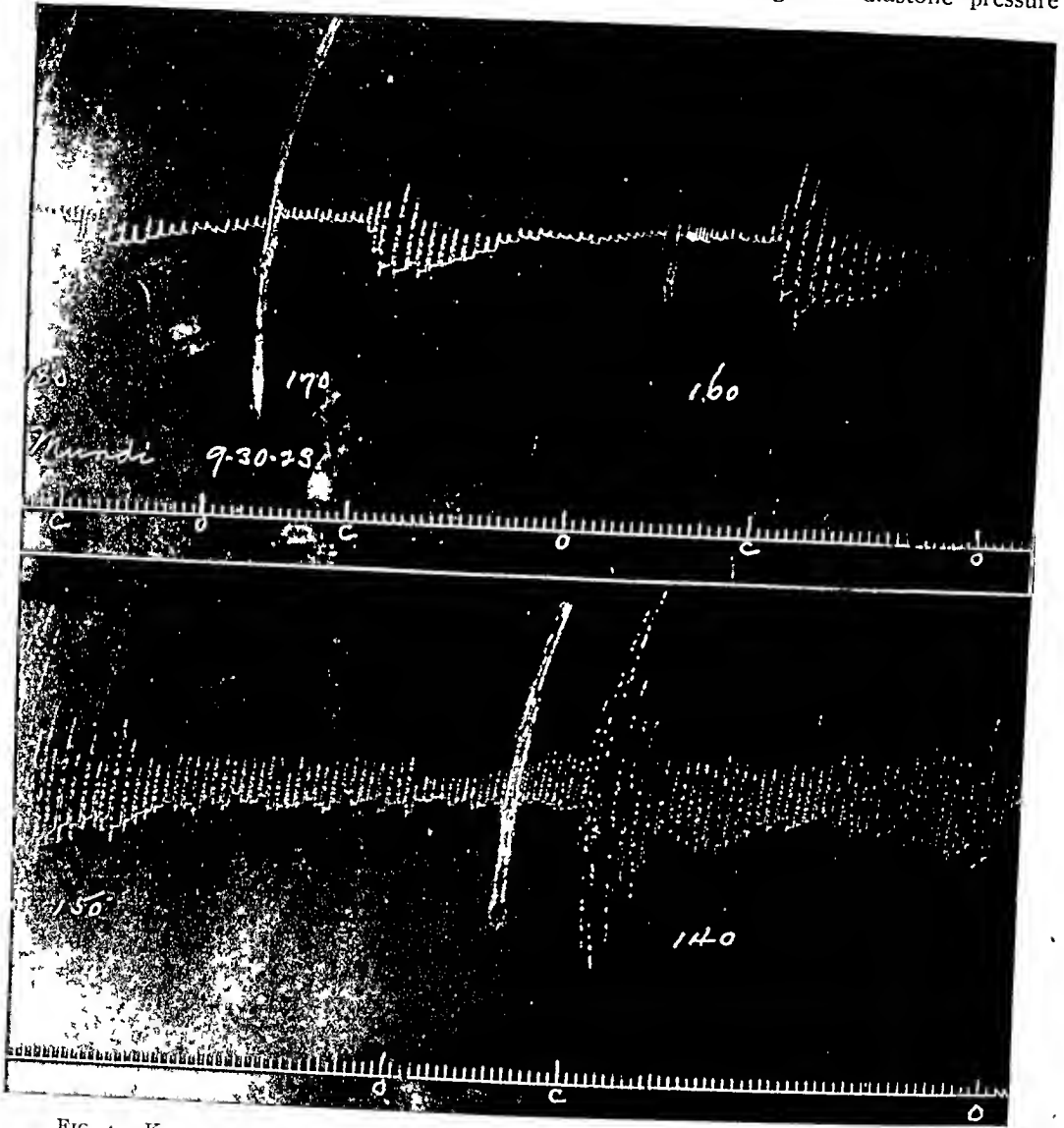


FIG. 4.—Kymographic records obtained by means of a modified Erlanger blood-pressure apparatus. With a pressure registration in the apparatus of 180 mm. Hg., 2 systolic beats were recorded on closing the fistula, 5 beats were recorded through a pressure of 170, 11 beats through a pressure of 160, 20 beats through a pressure of 150, and all the subsequent beats were recorded through a pressure of 140, indicating a systolic blood-pressure of 140 as long as the fistula was closed, C—Fistula closed. O—Fistula opened.

exactly paralleled the systolic fluctuations. Accompanying the increased blood-pressure, there occurred on closing the fistula a remarkable retardation in pulse rate from 80 to 40 beats with a gradual recovery to 60, where it remained as long as the fistula was closed.

As indicated in a previous article,⁷ this rise in blood-pressure is attributed to forcing

⁶ An Indirect Method for the Determination of Blood-pressure in the Unanæsthetized Dog, A. C. Kolls, Jour. of Pharm. and Exper. Therap., vol. xv, July, 1920.

⁷ The Physiology of an Arteriovenous Fistula, Emile Holman, Arch. of Surg., July, 1923, vol. vii, pp. 64-82.

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into the general capillary system the large volume of blood previously short-circuited through the fistula, the reduction in pulse rate being a compensatory adjustment for this increased pressure.

(B) *Atropine Eliminates the Retardation in Pulse But Not the Rise in Pressure on*

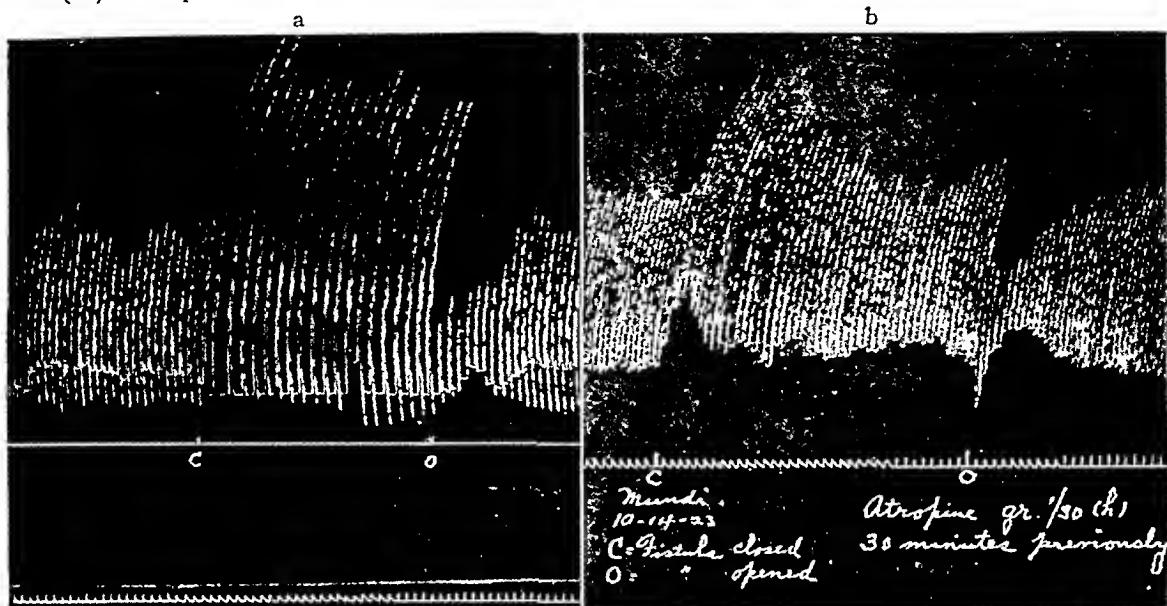


FIG. 5.—(a) Effect of closing fistula by digital compression: Increase in general blood-pressure with retardation of pulse. (b) Effect of closing fistula 30 minutes after the administration of atropine gr. 1/30: A rise in pressure but no retardation in pulse. C—Fistula closed. O—Fistula opened.

Closing the Fistula.—That the retardation in pulse is dependent almost entirely upon vagal stimuli was apparent from the following experiment: Closure of the fistula resulted as usual in an increase in pressure and a fall in pulse rate (Fig. 5a). Atropine, gr. 1/30,

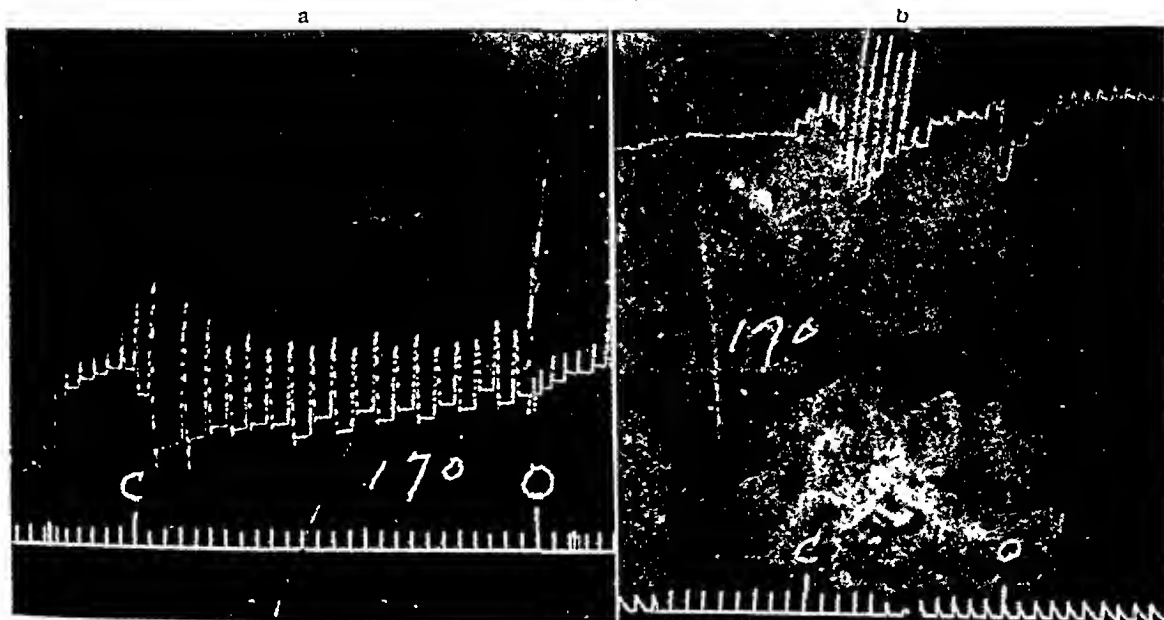


FIG. 6.—(a) With pressure in the Erlanger apparatus at 170 mm. Hg., closing the fistula resulted in recording several systolic beats, with marked retardation in pulse. (b) Following the administration of atropine, several systolic beats were recorded at 170 mm. Hg., on closing the fistula, but without retardation in pulse.

was administered subcutaneously, and thirty minutes later the fistula was closed without any effect on pulse rate (Fig. 5b). That an increase in pressure occurred was demonstrated by a kymographic record obtained with the pressure in the Erlanger system at 170 mm. Hg. On closing the fistula systolic beats were recorded coming through at this level, without a slowing of the pulse (Fig. 6b). The record normally obtained on closing the fistula showed the systolic beats coming through a pressure of 170, accompanied by

a marked retardation in pulse (Fig. 6a). The explanation of the retarded pulse is no doubt dependent upon a distention of the aorta by the volume of blood previously short-circuited through the fistula. This distention stimulates the depressor vagus fibres, and slowing of the heart is the inevitable result.

(C) *Röntgenological Studies of the Heart on the Effect of Closing the Fistula*—Observations were made on the changes in cardiac shadows dependent upon conditions



FIG. 7—Teleorontgenograms illustrating (a) (Fistula opened) Immense dilatation of heart due to presence of arteriovenous fistula. (b) (Fistula closed) Marked increase in cardiac and aortic shadows immediately after closure of femoral fistula by digital compression. (c) (Fistula still closed) Prompt subsidence of this increased dilatation within 20 seconds after closure. (d) Marked reduction in cardiac area two months after excision of fistula

at the fistula. The total transverse diameter of the heart before compression of the fistula was 168 cm. (Fig. 7) Immediately after compression it was definitely more dilated, measuring 17.6 cm. Within 20 seconds this increased dilatation had subsided, and the heart again showed a diameter of 167 cm, the fistula having been closing during this entire time. This illustrated conclusively that there was an immediate dilatation of the heart and also of the aorta by the sudden transfer into the general and capillary circulation of the volume of blood previously coursing through the fistula. Compensatory

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adjustments came into play immediately, such as the peripheral dilatation of the capillary and arteriolar beds, and the cardiac dilatation again subsided, even though the fistula remained closed.

(D) *Electrocardiograms to Illustrate Effect of Closing the Fistula.*—Electrocardiographic⁸ studies (Fig. 8), revealed a normal mechanism. It is evident from a study of the various records obtained (Fig. 9) that the first effect of closing the fistula was an immediate rise in blood-pressure. This increased pressure was then *followed* by a retardation in pulse rate which manifested itself only on the second or third cardiac contraction after closure of the fistula. This is a small but important corroboration of the hypothesis that the physiological mechanism for the maintenance of a uniform blood-pressure is

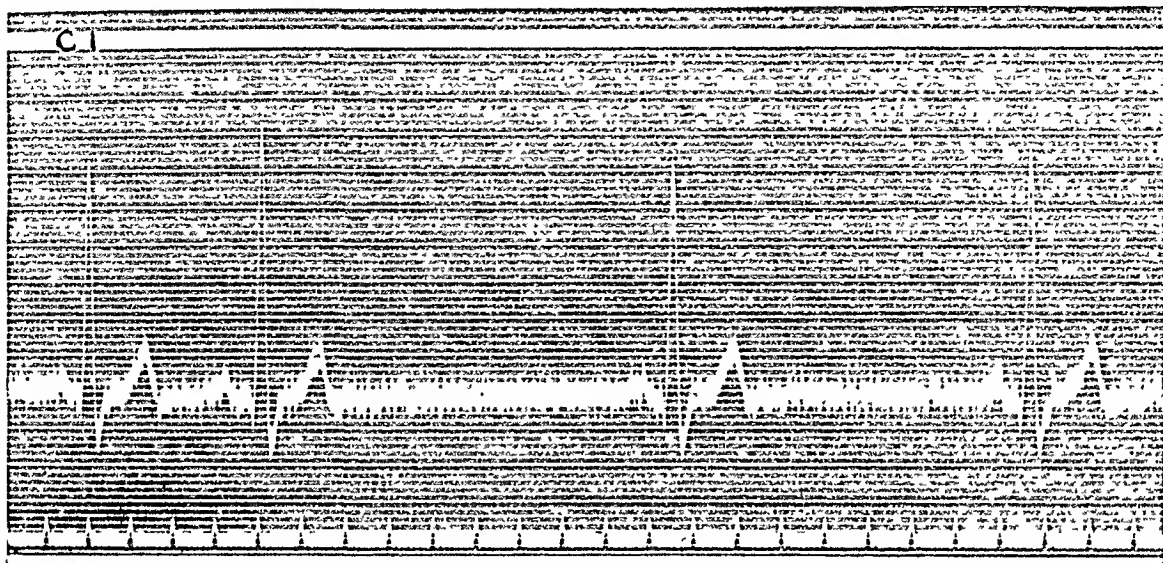


Fig. 8.—Normal electrocardiogram illustrating marked increase in pulse interval on closing fistula by digital compression. Lead I. C—Fistula closed.

responsible for the circulatory phenomena associated with arteriovenous aneurism. The retardation in pulse *follows* the increased pressure and is a compensatory mechanism to counterbalance this increased blood-pressure produced by closure of the fistula.

(E) *Effect of Closing the Fistula on the Systolic Heart Murmur.*—The systolic murmur heard over the whole precordium seemed definitely more pronounced with the fistula open than with the fistula closed. This was brought out much more clearly by the following method, which also revealed another important fact: Ten or twelve deep inspirations resulted in a supraeration of the lungs and in an acapnia. After complete expiration, which collapsed the lung entirely over the cardiac area, the patient was told to hold his breath as long as he could, and the various valve areas were auscultated in rapid succession. The supraeration of the lungs enabled the patient to hold his breath one or two minutes, allowing one to auscultate each valve area in turn and to make accurate comparisons among them. Before this method was attempted it was impossible for me to say definitely which valve was responsible for the systolic murmur, but during the prolonged acapnia it was evident that the murmur originated in the pulmonic area and not in the mitral or aortic areas. This method of studying heart murmurs may possibly be of value in determining their exact character in other valvular lesions.

(F) *Effect of Closing the Fistula on Vital Capacity.*—Closing and opening the fistula seemed to have some influence on the vital capacity as the following observations indicate:

- Fistula open: Vital capacity 2.17 litres.
- Fistula closed: Vital capacity 2.47; 2.37; 2.60; 2.35 litres.
- Fistula opened: Vital capacity 2.2; 2.15; 2.35 litres.
- Fistula closed: Vital capacity 2.4; 2.47; 2.57; 2.4 litres.
- Fistula opened: Vital capacity 2.2; 2.17; 2.3; 2.2 litres.

⁸I am indebted to Dr. A. Wilmaers, of Brussels, Belgium, for these studies.

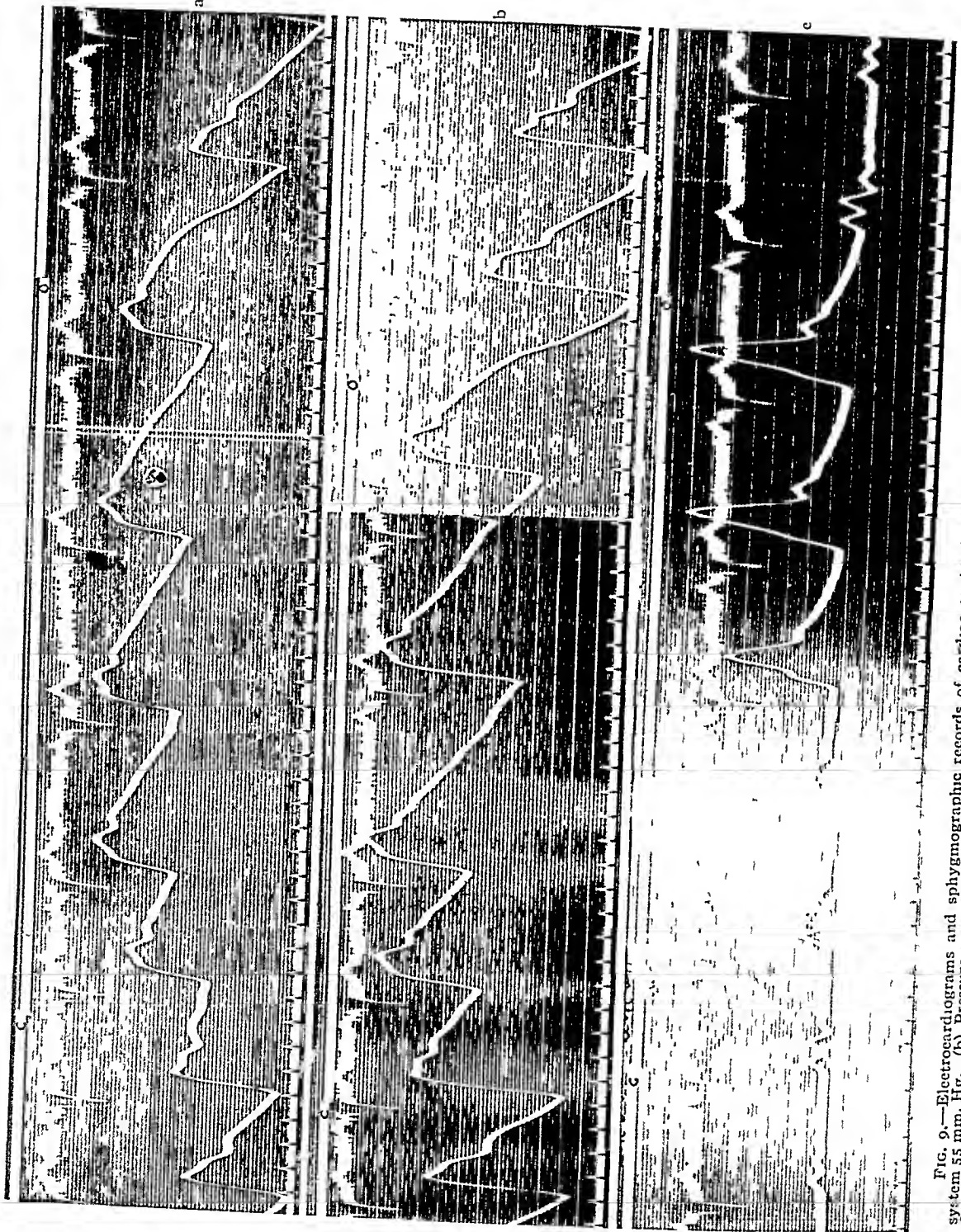


FIG. 9.—Electrocardiograms and sphygmographic records of cardiac contractions with fistula opened and fistula closed. (a) Pressure in system 55 mm. Hg. (b) Pressure in system 70 mm. Hg. (c) Pressure in system 140 mm. Hg. Records show that the first effect of closing the fistula is an increase in blood-pressure and the second effect a retardation in pulse. Readings obtained with a Pachon oscillogram. O, Fistula opened. C, Fistula closed.

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These readings suggest an increased vital capacity when the fistula was eliminated from the circulation. Post-operative readings have failed to confirm this, and so we must defer any conclusions from the above evidence.

Operation.—The marked increase in blood-pressure with the fistula closed and the known results of previous operations in reducing the greatly dilated hearts, resulting from arteriovenous aneurism, prompted us to undertake the elimination of the fistula by operation, partly in the hope that an improved circulation might have some influence in checking the progress of the spinal sclerosis.

On October 15, 1923, the patient was operated upon and the following conditions disclosed (Fig. 10). The vessels were exposed through a T-incision, dividing Poupart's ligament. Careful dissection revealed huge femoral and external iliac vessels. The external iliac artery was isolated and controlled about 3 cm. above the fistula by a broad tape. The dilated proximal vein was also isolated and controlled in the same manner. There was a large ampullar dilatation of the vein distal to the fistula, which ended abruptly at a point 2 cm. beyond the result probably of the old post-typhoid thrombophlebitis. All cardinal vessels having been similarly controlled with broad tapes, the artery and vein were separated. The large annular fistulous communication was fully 1.8 cm. in diameter. Numerous calcareous deposits were present in the arterial wall, preventing a dependable closure of the arterial opening. It was felt that the mere closure of the artery in the presence of these calcareous deposits might easily lead to a subsequent sacular aneurism at the point of closure through a weakened arterial wall. Accordingly the vessels were all permanently ligated, the fistula excised, and the wound closed without drainage. The circulation of the foot was observed at various intervals during the operation and found to be unimpaired at any time. Immediately following the excision of the fistula the stumps of the arteries distal to the fistula were beating quite as vigorously as the proximal arterial stumps, indicating a good circulation in the lower leg.

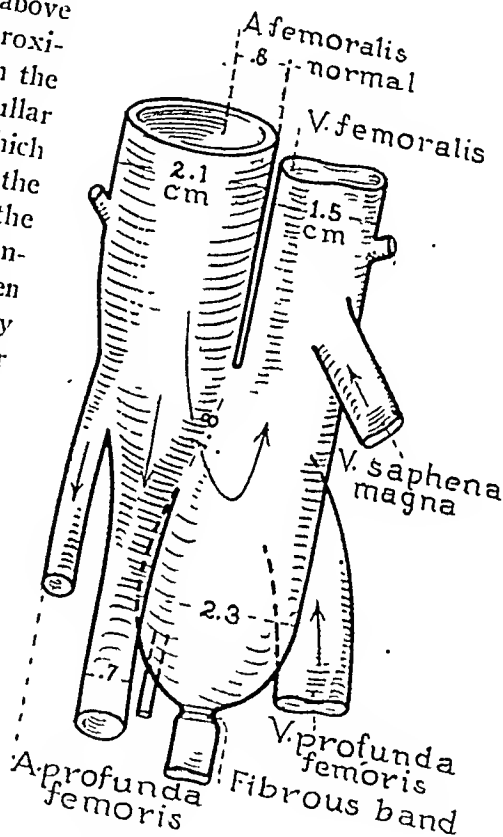


FIG. 10.—Conditions found at operation when fistula was excised.

Several interesting points were noted in the course of the operation. During the exposure of the vessels the pulse varied from 108 to 112. Closure of the artery proximal to the fistula resulted in an immediate reduction in pulse rate to 80 with obliteration of the continuous thrill. Simple closure of the vein proximal to the fistula, with the artery open, also obliterated the thrill and demonstrated that the free return flow to the heart is of prime importance in the development of the circulatory phenomena resulting from the fistula. Closure of the distal artery and vein had no effect upon the pulse. The permanent ligation of the artery resulted in a retardation of pulse to 84, which persisted during the remainder of the operation. At the conclusion of the four-hour procedure the pulse was only 80, and two hours later it had dropped to 60. This behavior of the heart rate is explained on the basis of an "auto-transfusion." By the excision of



FIG. 11.—Rontgenograms of heart. (I) Just before operation, October 15, cardiac area 18.2 cm. wide. (II) Immediately after operation showing a definite dilatation, cardiac area 18.8 cm. wide. (III) Five hours after operation, October 15, cardiac area 18.3 cm. wide. (IV) Second day after operation, October 16, cardiac area 18.1 cm. wide. (V) Third day after operation, October 17, cardiac area 17.9 cm. wide. (VI) Sixth day after operation, October 20, cardiac area 16.3 cm. wide

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the fistula, the heart and vessels of the general circulatory system became distended by the volume of blood previously short-circuited through the fistula.

Repeated X-ray studies of the heart gave corroborative evidence of this assumption.⁹ Immediately after operation, the cardiac shadow was definitely increased in area as compared to the pre-operative size (Fig. 11). Blood-pressure readings at this moment were only 98/68 with a pulse of 80. This low pressure was noted immediately after permanent ligation of the external iliac artery proximal to the fistula, and is probably explicable on the basis of a weakened heart muscle overdistended by the volume of blood previously short-circuited through the fistula. With a rapid reduction in blood volume, this acutely dilated heart subsided and by 7 o'clock, six hours after the conclusion of the operation, general blood-pressure had recovered to 122/78 with a pulse of 54, and the cardiac area

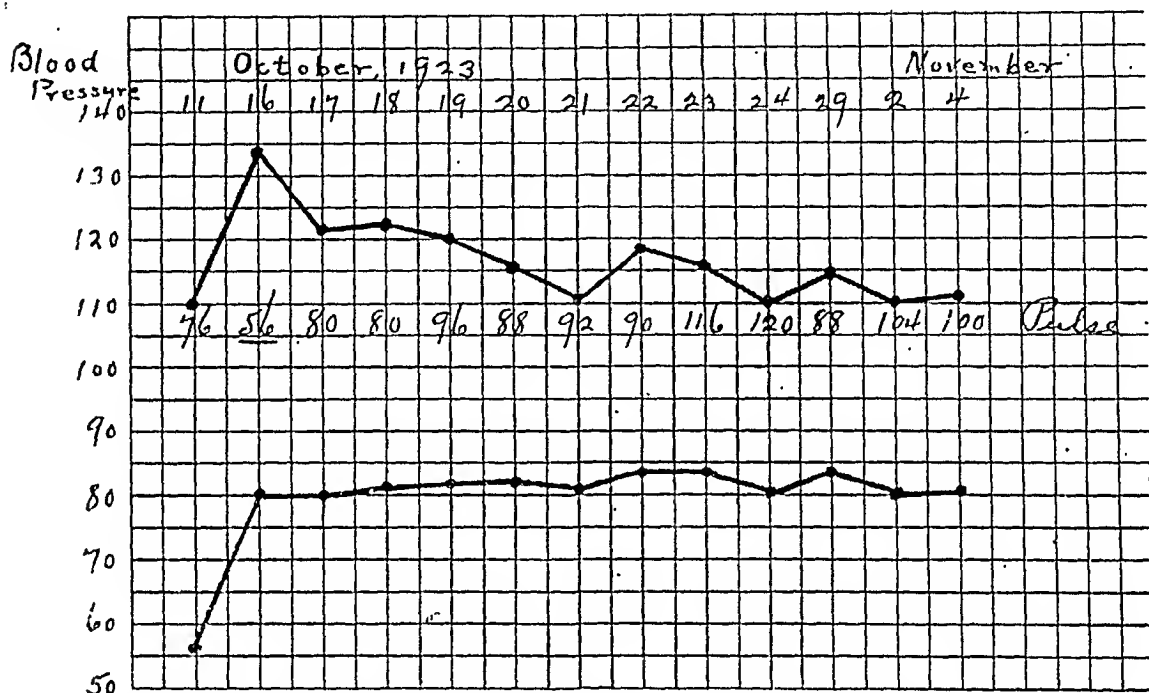


FIG. 12.—Behavior of blood-pressure and pulse following excision of the fistula on October 15. Note: (a) Temporary elevation of systolic pressure with marked retardation in pulse. (b) Permanent elevation of diastolic pressure. (c) Reacceleration of pulse on third day.

had subsided to its pre-operative size as shown in Fig. 11 (III). The rapid diminution in cardiac area during the first five days after operation is evident from an examination of the successive X-ray photographs taken during this period (Fig. 11). This diminishing cardiac area was demonstrable not only by X-ray, but also by physical examination. Within five days the apical beat had receded to the nipple line, 10 cm. from the mid-sternum, and within 15 days it was located 1 cm. medial to the nipple line. The marked systolic murmur present before operation was practically inaudible seven days after operation, a fact which identifies it rather intimately with the dilatation of the heart.

The behavior of blood-pressure after operation is illustrated in Fig. 12. On the day following operation a blood-pressure of 134/80 and a pulse of 56 were recorded. On the next day blood-pressure had fallen to 122/80 with a pulse of 80. The systolic pressure gradually fell to the pre-operative level of 110-120, but the diastolic level remained permanently elevated to 80, as compared to a pre-operative level of 56-58. This behavior of blood-pressure after operation was noted in my previous case of arteriovenous fistula, and has been reproduced experimentally in dogs. The gradual adjustment in systolic pressure is attributed to a gradual diminution in total blood volume, which no doubt had

⁹ I am indebted to Dr. Burgess Gordon, resident physician, for the post-operative X-ray examinations. A specially constructed bed enables him to make photographs with a portable apparatus without disturbing the patient.

increased in the presence of this large fistula, just as it does experimentally in the presence of large fistulæ.

Before operation, on one occasion only, the patient had exhibited the curious phenomenon of a "pulsus alternans" during the period in which the fistula was closed by digital compression. After operation, again on one occasion only, the same phenomenon was observed, but it was present only for a short period, and disappeared within a few hours. This was of particular interest since pulsus alternans in cardiac lesions is generally considered to indicate an unfavorable outlook.

A gradual and progressive improvement in the circulatory system was noted after operation, as judged mainly by the marked diminution in cardiac area and the elevated diastolic pressure (Figs. 7d and 12). A definite diminution in the size of the common iliac artery as determined by palpation was also noted. The patient's spinal symptoms were in no wise benefited by the operation and the evidence of sclerosis has continued to progress. Though it is tempting to speculate upon the possible relationship of the two lesions, they were probably independent of one another.

The case is of particular interest, first, because it corroborated many of our experimental observations, and secondly, because a marked cardiac enlargement and proximal dilatation of the vessels occurred in the presence of a large femoral fistula 1.8 cm. in diameter, a dilatation which almost entirely disappeared following the elimination of the fistula.

Several years previous to his death, the late Professor Halsted gathered from the literature of the world all the cases of arteriovenous fistula theretofore described, and lengthy abstracts were made available for an analytical study by Callander.¹⁰ This analysis did not include observations as to the size of the fistulous opening, and as this has proven to be of first importance in the subsequent development of visceral changes, it was considered advisable to review the abstracts made by Doctor Halsted with this point in mind. Important and confirmatory data was obtained, but more frequently than not the various authors' descriptions were necessarily meagre on the question of the size of the fistula, and even where it might easily have been included this important detail was lacking. A description of the size of the vessels and heart was also in many instances lacking or very inadequate. The following few examples, however, serve to illustrate the relationship between size of opening and the extent of the visceral changes.

C. B., No. 41803, J. H. H.¹¹ Femoral fistula (Hunter's canal) of many years' duration: "Artery proximal to the fistula was hugely dilated and tortuous. The heart was greatly enlarged. Fluoroscopic examination of the chest showed that the entire aorta was very much enlarged. Artery proximal to fistula 2 cm. wide, distal to fistula 1.2 cm. wide; vein 2.3 cm. wide proximally, 2 cm. wide distally. Fistula measured 2.7 cm. by 1.3 cm."

M. H., No. 54125, J. H. H. Femoral fistula (Scarpa's triangle) of many years' duration, accompanied by a markedly dilated heart and by a considerable dilatation of the proximal vessels. The fistula was excised by Dr. M. R. Reid with rapid subsidence of the dilated heart. Size of fistulous opening: 2 cm. by 1 cm.

¹⁰ Curle L. Callander: Study of Arteriovenous Fistula with an Analysis of 447 Cases, Johns Hopkins Hospital Reports, vol. xix, 1920.

¹¹ Cited in the Effect of Arteriovenous Aneurism on the Heart and Blood-vessels, by M. R. Reid, Johns Hopkins Bull., 1920, vol. xxxi, p. 43.

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C. W.¹² Popliteal fistula of 24 years' duration resulting in a marked enlargement of the heart with extreme dilatation of the vessels proximal to the fistula. Size of fistula: 2.1 cm. in diameter.

Baker's Case:¹³ Varicose aneurism at origin of profunda artery between femoral vessels of years' duration. "Heart greatly dilated in all its cavities. Walls hypertrophied. Ascending aorta dilated. Communicating aperture 1 inch in diameter."

Keyes' Case:¹⁴ Varicose aneurism of lower popliteal vessels. Autopsy: "Sac size of goose's egg. Two large circular openings were found at the upper end of sac, the popliteal vein and artery, each opening *as a full circle* at about a middle point of the sac. The popliteal vein was dilated and thickened, the popliteal artery proximally was dilated."

Bank's Case:¹⁵ Aneurismal varix of femoral vessels of six years' duration. "Artery above the point of communication was *somewhat* enlarged, below the communication the artery was contracted. Proximal vein was greatly enlarged. Diameter of the fistulous opening $\frac{3}{16}$ of an inch, somewhat oval in shape."

Roberts' Case:¹⁶ Femoral fistula (Hunter's canal) of six years' duration. Autopsy material (examined one year after preservation in alcohol) showed: "Common iliac artery on affected side twice as large as on sound side. Femoral vessels in collapsed state each measured about $\frac{1}{2}$ inch in width. Below the orifice of communication the vein is practically the same size as it is above, but the artery below the fistula is only about half as large as above the fistula. The fistula, itself, was a circular opening about $\frac{3}{8}$ of an inch in diameter with smooth edges."

Graves' Case:¹⁷ Aneurismal varix of middle third of femoral vessels of six years' duration. Autopsy findings: "Femoral and iliac vessels, both artery and vein, dilated to a size larger than an adult thumb and were greatly thinned. Fistulous opening $\frac{1}{3}$ to $\frac{1}{4}$ of an inch, directly between the vessels."

Da Costa's Case:¹⁸ Aneurismal varix of popliteal vessels of three months' duration. Operation: "Vein and artery directly fused—no intervening sac. Artery distally small, proximally much dilated. Vein distally and proximally very much dilated and thickened." Operation was performed under a tourniquet, and the opening between the vessels was illustrated as being 1.5 cm. by 0.5 cm. in size.

Eisenbrey's Case:¹⁹ Aneurismal varix of femoral vessels of 18 years' duration. Autopsy: "Hypertrophy and dilatation of the heart. Artery and vein dilated proximal to the fistula, each measuring 2.5 cm. in diameter. Communication between the vessels measures 0.7 cm. in diameter."

Hodge's Case:²⁰ Femoral fistula of 16 years' duration. Condition found at operation: "The two vessels, which were found to be enlarged, were joined together toward the

¹² Full Description in the Physiology of an Arteriovenous Fistula, by Emile Holman, Arch. of Surg., July, 1923, pp. 64-82.

¹³ Baker, A.: Varicose Aneurism of Profunda Femoris at its Origin. Prov. Med. and Surg. J., 1850, vol. xiv, p. 158.

¹⁴ Keyes, E. L.: Arteriovenous Aneurism, Virginia Med. Mon., 1881-2, vol. viii, pp. 644-659.

¹⁵ Banks, C. E.: Case of Aneurismal Varix Involving the External Iliac and Femoral Vessels. Rep. U. S. Marine Hosp. Service, 1882, p. 150.

¹⁶ Roberts, John B.: A Case of Varicose Aneurism of the Thigh. ANNALS OF SURGERY, 1895, vol. xxii, p. 372.

¹⁷ Graves, S. C.: Arteriovenous Aneurism of the Femoral Vessels. Am. Med., 1903, vol. v, p. 962.

¹⁸ Da Costa, J. C.: Operation for Aneurismal Varix of the Popliteal Vessels. ANNALS OF SURGERY, 1912, vol. lv, p. 593.

¹⁹ Eisenbrey, A. B.: Arteriovenous Aneurism of the Superficial Femoral Vessels. Jour. A. M. A., 1913, vol. lxi, p. 2155.

²⁰ Hodge, E. B., and Sweet, J. E.: Arteriovenous Aneurism of the Femoral Artery and Vein. Trans. Phil. Acad. Surg., 1915, vol. xvii, p. 209.

end of the enlargement by a channel about $1\frac{1}{2}$ inches in length, the actual communication appearing to be $\frac{3}{4}$ of an inch wide."

Guinard's Case:²¹ Fistula of middle third of femoral vessels of two years' and three months' duration. No dilatation of artery or vein. Orifice of communication the "size of a lentil," *i.e.*, about 3 to 4 mm. in diameter.

Bergmann's Case:²² Varicose aneurism of upper popliteal vessels of six months' duration. Operation: "Artery was *not* dilated, vein dilated to three times its usual size. Opening of artery into the vein was scarcely 3 mm. in diameter."

Wiesinger's Case:²³ Low popliteal fistula of 18 months' duration. Vein enlarged, artery *not* enlarged. Opening in the artery 3 mm. long.

Cranwell's Case:²⁴ Fistula of popliteal vessels of six years' duration. Operation: "The artery was of *normal calibre*. The popliteal vein below the fistula was much thickened (arterialized). . . . It was a true arteriovenous fistula, the canal being about 3 or 4 mm. broad by the same measurement in length."

It is apparent from a study of the last four cases that fistulæ only three to four millimetres in diameter do not cause any change in the proximal artery, although in three instances dilatation of the proximal vein was recorded. This has also been noted experimentally. It is evident also that duration of the fistula is a factor of minor importance in the development of these vessel changes. A large fistula of three months' duration (Da Costa) resulted in marked enlargement of the proximal vessels, whereas a small fistula of six years' duration (Cranwell) was accompanied by vessels of normal calibre. That large fistulæ invariably cause marked visceral changes is illustrated by the case of Charles Mundi and by eleven cases from the literature, in which the vessels were uniformly enlarged. The size of the heart was not always mentioned, but its enlargement has only been noted in the presence of fistulæ large enough to cause changes also in the proximal artery.

CONCLUSIONS

Clinically, the circulatory changes following the introduction of an arteriovenous fistula are dependent primarily upon the size of the fistula and upon an unobstructed return flow to the heart. Small fistulæ, however long they may have existed, do not cause changes in either vessels or heart. Slightly larger fistulæ may result in an enlargement of the proximal vein, but no visible change in the heart or proximal artery. Large fistulæ are inevitably accompanied by changes in both artery and vein and usually by a demonstrable enlargement of the heart. The extent of these changes is intimately dependent upon the size of the fistula.

These clinical observations are identical with those found in the experimental laboratory and are undoubtedly dependent entirely upon the amount of blood which finds its way through the fistula back to the heart.

²¹ Guinard, A.: Bull. et Mem. Soc. de Chir. Par., 1902, vol. xxviii, p. 1125.

²² Bergmann, E.: Zur Casuistik des arteriell-venösen traumatischen Aneurysma. Arch. f. klin. chir., 1903, vol. lxix, p. 515.

²³ Fall von Aneurysma arterio-venosum, Wiesinger, D. Med. Woch., 1904, vol. xxx, s. 157.

²⁴ Contribution à l'étude du traitement de l'anéurisme artérioveineux. Cranwell, J., Rev. de Chir., 1906, vol. xxxiv, p. 817.

BONE TUMORS. MYXOMA*

SECOND PAPER WITH REPORT OF THREE NEW CASES

BY JOSEPH COLT BLOODGOOD, M.D.
OF BALTIMORE, MD.

THE first complete report was published in the ANNALS OF SURGERY in December, 1920 (vol. lxxii, p. 713). The point emphasized in this report was that every myxoma of bone on record had recurred locally, and three of the cases reported died of metastasis. (A fourth subsequently died of metastasis to the lungs and was reported in the ANNALS OF SURGERY for January, 1923.)

Myxoma Other Than of Bone.—Apparently myxoma growing outside of bone is less malignant both as to local recurrence and internal metastasis. I have two cases of pure myxoma of the breast in which the tumors were excised without exploratory incision, one by Doctor Tyler, of Greenville, S. C., and the other by Doctors Thalheimer and Saltzstein of Columbia Hospital, Milwaukee, Wis. Both of these patients are well, one more than three, the other more than five years since operation. These myxomas somewhat resembled in the fresh the myxoma of bone, but they were firmer and when pressed did not exude a liquid tapioca-like material, or break up into particles like vesicles of a thin mucilage consistency. Under the microscope these myxomas show the lymphoid and stellate cells, but the stroma takes a little of the eosin staining, and there is evidently more fibrous tissue than in the myxoma of bone.



FIG. 1.—Case I. Pathol. No. 33423. Gross tissue floating in a hemorrhagic fluid. The white tapioca particles mixed with the tumor tissue stained dark by blood resemble the tissue in Fig. 11.

The connective-tissue part of the so-called intracanalicular myxoma of the breast differs from these two cases of pure myxoma in being less gelatinous, firmer, and under the microscope we rarely see the lymphoid or stellate cells. The characteristic feature of this adenoma of the breast is that the stroma takes the stain very lightly and resembles the stroma forming the envelope of the ducts and acini in the normal breast. These intracanalicular myxomas of the breast may recur when they are shelled out, but the recurrent tumors have always been benign, and the patients have never died of metastasis.

The myxomatous part of the so-called mixed tumor of the parotid and

* Read before the American Surgical Association at the Meeting in Baltimore, May, 1924.

neurofibroma is more like myxoma of bone, but in the gross rarely so gelatinous. But these two tumors do not show the same vitality in local recurrence when exploratory incision is made.

In the first paper on Myxoma and in a recent paper on Xanthoma[†] and in other contributions, I have drawn attention to the danger of local recurrence when tumors, even benign tumors, and even encapsulated benign tumors, are enucleated or "shelled out." The best example is the mixed tumor in the region of the salivary glands. The percentage of local recur-



FIG 2—Case I Pathol No 33423 From the first operation, curetting in June, 1922 The hemorrhagic part is separated from the myxomatous tumor by condensed cellular tissue, suggesting spindle-cell sarcoma

rence here is larger. This can be explained by the fact that surgeons fear injury of the facial nerve, and for this reason practice enucleation or shelling out. Perhaps in the neurofibroma local recurrences take a second place, especially if the tumor is near a large nerve trunk. In the intracanalicular myxoma of the breast local recurrence is less frequently recorded, because most surgeons cut these tumors out, as taking away a little larger

zone of breast tissue is not mutilating. However, in the myxoma of bone, there is additional danger if one even cuts into the tumor—the danger of transplantation of tumor cells into the open wound.

Definite sarcoma not differing from any other type of sarcoma may develop in any of the connective-tissue tumors, apparently more frequently in a benign tumor containing myxomatous tissue. The most common sarcoma of the breast arises in the intracanalicular myxoma. Why sarcoma is more frequently observed in neural fibroma than the myxomatous tumor in the region of the salivary glands, I cannot explain.

In one of the cases reported in my paper in 1920, in which the primary tumor was located in the astragalus, there was definite metastasis of pure

[†] Archives of Surgery, May, 1924, vol viii, p 882

myxoma to the tubercle of the tibia after amputation above the ankle-joint (Case II, Fig. 11).

Unfortunately I have never been able to obtain the lung metastatic tumor in any of these cases of myxoma of bone.

Central Myxoma of Phalanges.—In the older literature which I have discussed in *Progressive Medicine*, and in my paper on Bone Cysts in the ANNALS OF SURGERY for August, 1910, cases of central myxoma of the phalanges are reported. This group of tumors in the phalanges of fingers

and toes have been constantly restudied since. Unfortunately in not a single instance in which the original diagnosis was myxoma have we any sections to prove it.

In all the recent cases in which we have tissue and sections none are myxoma—all are chondromas. Therefore, either the myxoma of the phalanges are less malignant, or the older diagnoses were incorrect. On the theory of probabilities, myxoma should now and then be seen in the pha-

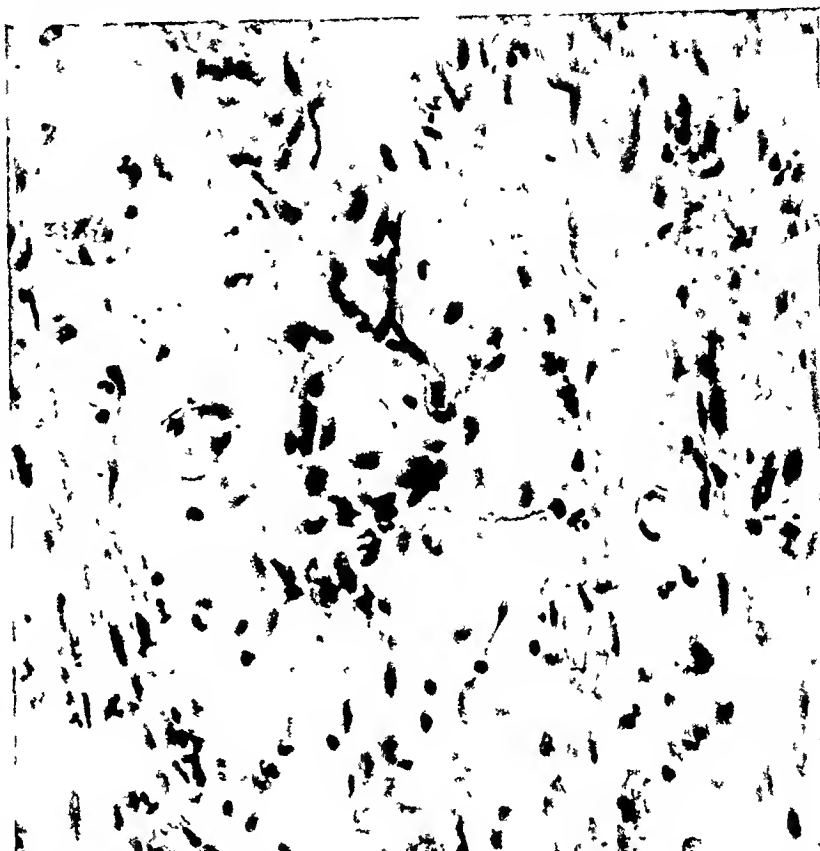


FIG. 3 —Case I. Pathol. No. 33423. Recurrent tumor tissue in a bone cavity. Observe the blood-vessels and blood mixed with myxomatous tissue.

langes, because this tumor occurs where the chondroma does, and it is suggestive that it is a degeneration of a primary chondroma, but the practical fact remains that the few cases diagnosed myxoma, situated in the phalanges and curetted without chemical or thermal cauterization have not recurred locally, nor given rise to metastasis. My colleague Doctor Baer of Johns Hopkins curetted such a case some years ago and has recently sent me an X-ray showing complete ossification. I remember distinctly the gross appearance in this case and my written report strongly suggests a myxoma, but tissues and section have been lost.

For reasons which at present we do not know, all connective-tissue tumors arising from the soft parts and bone in the region of the phalanges of the fingers and toes are benign. We have only one example of sarcoma which was part of a multiple endothelial sarcoma of the phalanx of the great toe, tibia and femur.

I am rather inclined to feel that a surgeon exploring a central tumor of a phalanx and finding the gross and microscopic picture of a myxoma, would be justified in curetting with thermal (cautery) and chemical cauterization.

Central Myxoma of Metacarpals.—What has been said of the phalanx applies to the metatarsal and metacarpal bones.

Tumors of the Carpus.—Up to the present time I have never observed any type of malignant tumor of the carpal bones.

Central Tumors of the Tarsal Bones.—My experience has been with the

astragalus and os calcis only. The possibilities are: bone cysts, giant-cell tumors and myxomas. The giant-cell tumor is the most common. There is no way of diagnosing it in the X-ray. If one explores a central tumor of the astragalus or os calcis and exposes a bone cyst or giant-cell tumor, curetting with thermal and chemical cauterization is sufficient. All of the cases of which I have records are well. Doctor Prince, of Rochester, has had an unusual experience

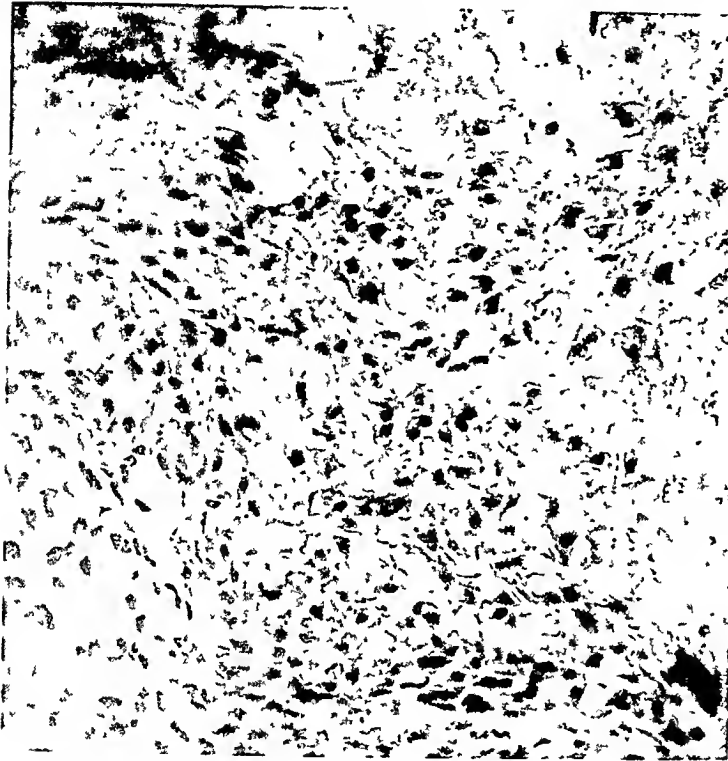


FIG. 4.—Case I. Pathol. No. 33423 A section from a recurrence two months later than Fig. 3. Typical myxomatous cells, but less intercellular myxomatous tissue

with this group. If, however, the central tumor suggested in the gross and in the frozen section a myxoma, I would immediately burn the wound with the cautery, clean up the leg above the ankle and with a new set of instruments, *amputate*, in order to avoid the local recurrence and perhaps death from metastasis as recorded in Case II of my paper of 1920.

Central Tumors of the Long Pipe Bones.—The problems of diagnosis here are easier, but the correct method of treatment for myxoma is not yet established, although one should be inclined to choose resection or amputation.

My studies up to date emphasize that the myxoma, either central or periosteal, is for practical purposes a sarcoma with a much greater tendency to recurrence from wound transplantation and with a longer interval before death from metastasis.

It is important to repeat here that all the older surgical pathologists as far

BONE TUMORS. MYXOMA

back as 1840 wrote: "The myxoma of bone is a benign tumor, but it always recurs after operation."

They did not observe their cases long enough to know of the metastasis. Many of my colleagues have not accepted this classification into central and periosteal tumors of the long pipe bones, which, as a matter of fact is not mine and not new. I am one of the few who look upon it as one of the fundamental facts established by the older observers of bone tumors.

More recent investigations allow some very positive deductions based upon



FIG. 5.—Case I. Pathol. No. 33423. Appearance of the wound August 25, 1923. There had been three intensive burnings with the soldering irons, in attempting to destroy all the soft parts about the recurrent tumor and all the cavities containing tumor in the trochanter and shaft.

the age of the patient and on whether the tumor involved the diaphysis or epiphysis.

When the patient is under eighteen and, more certainly, when under fifteen, a distinct central tumor of the shaft of a long pipe bone is always benign. The majority of cases are benign bone cysts, a very few—less than two per cent.—the benign giant-cell tumor, with now and then an isolated case of tuberculosis. I am looking now at the X-ray of a central tumor (due to tuberculosis) of the shaft of the tibia in a girl aged eleven years. The bone shell is intact (see Fig. 60, *Progressive Medicine*, December, 1900, page 2080). In the twenty years I have a record of but two other cases (see *Journal of Radiology* for March, 1920, Figs. 37, 38).

If the central tumor is in the epiphysis, and the patient is under eighteen and, more certainly if he is under fifteen, the tumor is usually a giant-cell tumor, but may be a bone cyst or tuberculosis. This localization in the epiphysis is very rare for the bone cyst, and this age is very uncommon for the giant-cell tumor.

When the patient is an adult and the central tumor involves the epiphysis,



FIG 6—Case I. Pathol No. 33423. X-ray October 10, 1923. The patient is apparently well; the last section showed no tumor. The new bone formation outside the shaft and trochanter is largely the result of two previous operations and repeated cauterizations.

cautery and the fact that a central tumor in the shaft of a long pipe bone of an adult is rarely a giant-cell tumor or a cyst, this thermal cauterization might have been employed at the time of the first exploration and curetting in June, 1922, instead of after the second curetting for recurrence in July, 1923.

Case II suggests that it is possible to recognize the central malignant tumor from the clinical history, in the X-ray and by palpation, and perform amputation or resection without an exploratory incision.

In Case III the operator, Doctor Rockey, was not suspicious of myxoma, or a central lesion other than cyst or giant-cell tumor in the lower end of the femur, but at the exploratory incision he recognized in the gross an unusual tissue and for this reason used the hot soldering irons. This patient is clinically well with a good functioning limb nine months after operation.

the chances are that it is a benign giant-cell tumor. But chondroma, myxoma and sarcoma are possible. When the central tumor involves the shaft of an adult bone, one can almost exclude a bone cyst or giant-cell tumor, and one must think of myxoma, chondroma, myeloma, metastatic tumors, and the very rare sarcoma. I am able to report three additional cases of myxoma since my paper in 1920.

Case I is chiefly of interest because the recurrent tumor in the shaft of the upper third of the femur has resisted repeated cauterizations with plumbers' soldering irons for a period of more than a year.

Had the operator in this case been familiar with the use of the



FIG 7—Case I. Pathol No. 33423. X-ray September 25, 1924, before the last operation for recurrence. Compare with Fig 6. There is an area of bone destruction and in this cavity tumor was found.

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CASE I.—Pathol. No. 23423. First observed July, 1923. *Central myxoma of the upper shaft of the femur* extending to greater trochanter; recurrent one year after curetting without chemical or thermal cauterization.

In this Case I have the tissues of the first operation and from the operations for recurrence, and of the last recurrence (September 20, 1924). The tumor is still a pure myxoma, both, in the gross and microscopic (see Figs. 1, 2, 3 and 4).

The next most important fact in this case is that in June, 1922, two years and four months ago, on the diagnosis of a bone cyst, the bone shell was opened and the contents curetted out.

There was no chemical or thermal cauterization.

On July 23, 1923, because of recurrence, shown by palpation, X-ray and pain, a second operation was performed by the same surgeon, and because of the profuse hemorrhage after curetting, the wound was packed.

A few days later this wound was thoroughly cauterized with the hot soldering irons.

August 8, 1923, less than two weeks after the second operation, the patient was admitted to St. Agnes' Hospital, and the open wound again cauterized with the thermal cautery. This cauterization has continued at intervals for now more than one year. In spite of this at the last operation (September 20, 1924) pure myxomatous tissue was found in a bone cavity below the great trochanter.

The patient still walks with a cane, and for at least one year has been able to continue his work as a postal clerk. The cauterizations every three to six weeks under gas anesthesia have kept him in the hospital from three to five days.

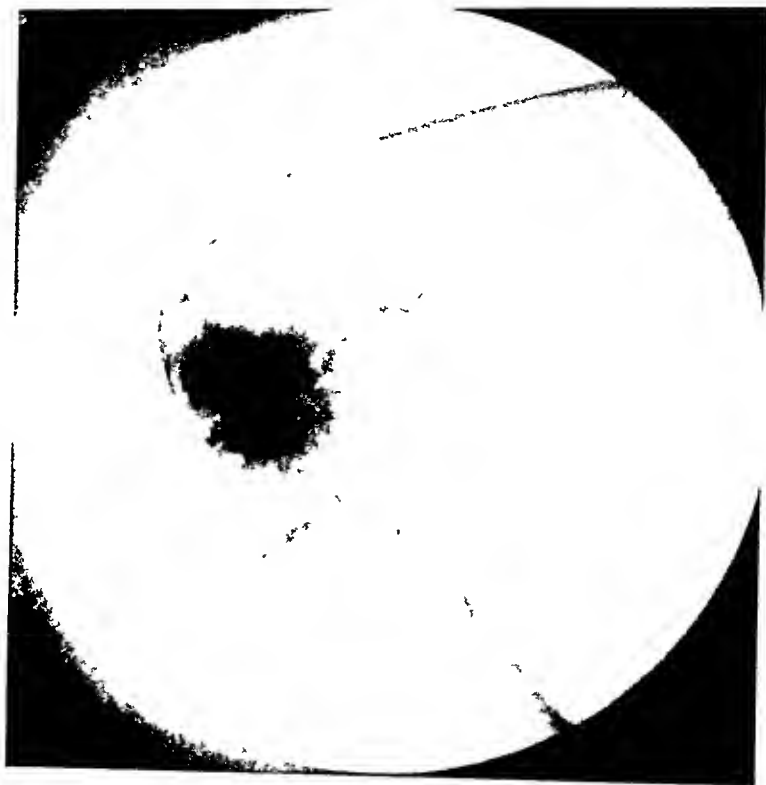


FIG. 8.—Case II. Pathol. No. 34522. X-ray taken in 1920 and diagnosed a benign ossified lesion.

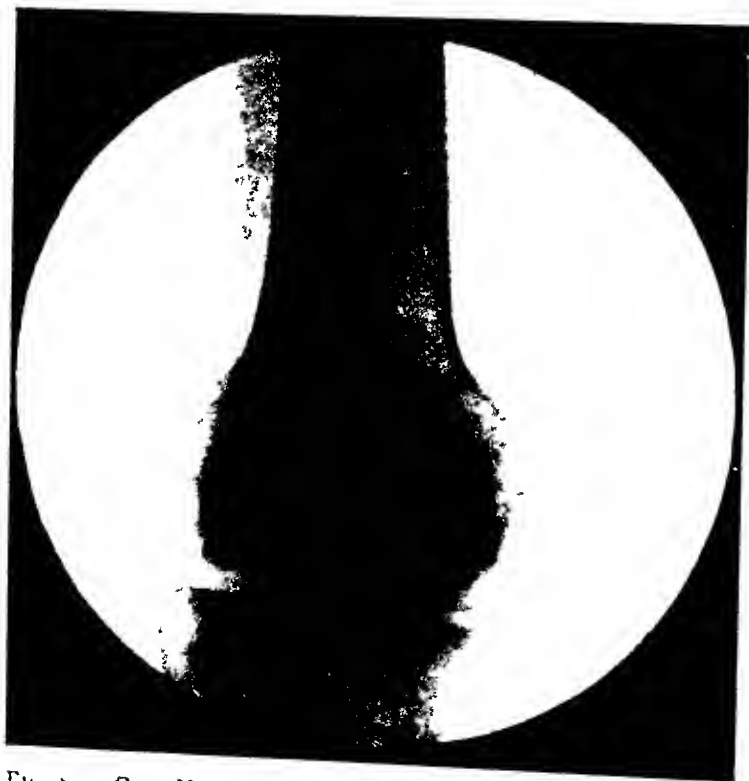


FIG. 8A.—Case II. Pathol. No. 34522. X-ray taken in 1920 and diagnosed a benign ossified lesion.

When I exhibited this patient before the American Surgical Association in May, 1924, the open wound was clean, and there was no gross or microscopic evidence of recurrence.

We have, therefore, demonstrated the failure of the thermal cautery and the deep X-ray to check or destroy the local growth of a recurrent central myxoma. At the present time there are no signs of metastasis to the lungs.

Clinical History (Case I), taken before the operation in June, 1922. First, there is a distinct history of a direct trauma to the region of the great trochanter of the right femur, in a white male aged forty-nine, whose occu-

pation is that of a mail clerk. The pain after this trauma lasted but a few days, and there was an interval of almost two years before the occurrence of severe pain in the region of the great trochanter, upper end of femur, and sacroiliac joint, and this pain had been present for more than one year before the operation in June, 1922.

Pain in Myxoma.—We have not a sufficient number of cases to come to any definite conclusions, but so far my records show that an intense, persistent pain in a bone lesion in which the X-ray shows an intact bone shell, is very suggestive of myxoma or rare sarcoma. I have, however, observed it on a few occasions in the giant-cell tumor, very rarely in the bone cyst.

FIG. 9.—Case II. Pathol. No. 34522. X-ray, lateral view, of myxoma of lower end of femur, shaft and epiphysis, with remains of the old lesion in the condyle shown in Fig. 8. Note there is no expansion; minute perforation of cortical shell; evident tumor shadow with, perhaps, some bone formation outside the cortical shell, both anteriorly and posteriorly.

X-rays and Palpation.—The surgeon who operated in June, 1922, reports that he could palpate a swelling below the great trochanter on the outer lateral surface of the right thigh with a distinct bone shell. The X-ray report notes a definite central lesion occupying the greater trochanter, extending to the shaft about the size of a hen's egg. The outer bone shell is thin, but the shaft of the femur and the great trochanter are only partially invaded. Unfortunately this X-ray film is lost.

Clinical and X-ray Diagnosis.—The one made at that time by the surgeon and the röntgenologist was *bone cyst*.

From my experience, the location and the age almost ruled out the bone cyst and the giant-cell tumor—too old for the bone cyst and unusual position for the giant-cell tumor. One should have thought of myxoma, chondroma or a possible sarcoma. The history of the intense pain also suggested the more

malignant types—myxoma and sarcoma. For this reason the patient should have been prepared for the immediate cauterization with a heavy soldering iron.

Gross Pathology of First Operation.—The operator informed me that there was no distinct connective-tissue lining as is usually found in the bone cyst, and no red, granular, vascular tumor so characteristic of the giant-cell tumor, but a viscid, whitish, thick fluid containing masses like tapioca. This almost describes the myxoma, and resembles the contents of the cyst found at the second operation.

Recurrence After First Operation.—The wound healed, and the patient was relieved of pain for a few months. Then there were similar recurrent pains which radiated from the great trochanter towards the sacrum around the hip and down the thigh. A few months later a mass could be palpated, and recurrence was diagnosed by the original operator.

X-ray of Recurrence (July 1, 1923).—I examined this patient July 10, thirteen months after the first operation, at least eight months after the recurrence of the pain, and three or four months after the appearance of a visible and palpable swelling in the scar, and I examined this X-ray and further X-rays were taken by Doctor Kahn in my office.

Unfortunately they have been mislaid or lost. (I took them with me to another city for a demonstration and returned without them.) But this X-ray and the ones which we have taken subsequently and which are reproduced here, differ very little from the description of the X-ray before the first operation, except that the cyst is larger; no marked destruction of the shaft appears in the X-ray. There is nothing in any of these X-rays to distinguish the type of tumor—it could be a cyst, a giant-cell tumor or a chondroma. In the X-ray taken after the first operation, I was surprised to find a reformation of the bone shell which had been removed, with considerable evidence of new bone formation toward the great trochanter, and a cavity the size of a hen's egg as described in the first X-ray. The larger part of the cyst was outside the trochanter and shaft, an expansion carrying with it the envelope of bone shell. The swelling at the time of my examination was fully the size of a grape-fruit (12 cm.), and, when I dictated this note



FIG. 10.—Case II. Pathol. No. 34522. Anteroposterior view, not as clear as Fig. 9. The remains of the tumor shown in Fig. 8 are seen here in the internal condyle. This X-ray immediately should make one suspicious of myxoma or sarcoma. The disease has broken through the bone shell without expansion.

July 10, the patient was free from pain, there was no tenderness, and very little limitation in flexion and rotation at the hip-joint. The patient was walking without crutch or cane, and able to work. There were no signs of recurrence in the soft parts and, to repeat, a distinct reformation of the bone shell. For this reason I was rather inclined to the diagnosis of chondroma which had liquefied, because in myxoma, I rather felt from my previous experience that there would be recurrence in the soft parts. This

case shows how difficult it is when the number of cases is small, to be certain of any conclusion based upon such previous experience.

The patient returned home and, because of intense pain, the original operator explored, evacuated the contents of the bone shell and, as stated before, packed for hemorrhage. A few days later, at my suggestion he thoroughly cauterized the wound with soldering irons.

Pathology of Second Operation.—The material sent to the laboratory was a thick viscid fluid stained with blood and filled with small and large masses which consisted of opaque, gelatinous tissue not unlike tapioca, imbedded in tissues stained with blood. Fig. 1 is one of the larger pieces. Figs. 2, 3 and 4 show the microscopic appearance: certainly a myxoma, and some pathologists would say a myxosarcoma.

Fig. 5 taken August 25, 1923, after three intensive cauterizations at St. Agnes' Hospital, shows the open wound. Fig. 6 is an X-ray

FIG. 11.—Case II. Pathol. No. 34522. Longitudinal section through lower end of femur, formalin-hardened specimen. Compare with Fig. 10 (X-ray).

taken October 20, 1923, after repeated cauterizations, at a time when the patient showed no evidence of disease in the wound. Figure 7 is an X-ray taken September 25, 1924. You will observe that the area of destruction has appeared in the shaft below the trochanter, and in this cavity we found gross and microscopic evidence of tumor tissue. To repeat, there is no evidence of metastasis to the chest. The patient is free of pain, walks with a cane and continues at work in the Post Office Department.

Discussion.—I have called attention to this in previous communications, and the records of the bone tumors accumulated in the past few years emphasize the importance of this statement: No surgeon should explore a bone tumor without being prepared to cauterize the wound. The thermal cautery is far

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stronger than any chemical cauterization, and fortunately the best cautery is the cheapest—the plumbers' soldering irons.

This case cannot be looked upon as a fair test of the use of the cautery in the treatment of myxoma. We shall have to follow the result in the third case. It does, however, confirm the conclusions of the previous papers on myxoma—its tendency to local recurrence. I am convinced that no local disease has ever received a more thorough treatment with the thermal cautery and the deep X-rays than in this case.

At this time (September, 1924) resection was out of the question and amputation, of course, meant hip-joint disarticulation. From previous experience amputation does not promise protection against metastasis. We have given this man a useful limb for two years since first curetting.

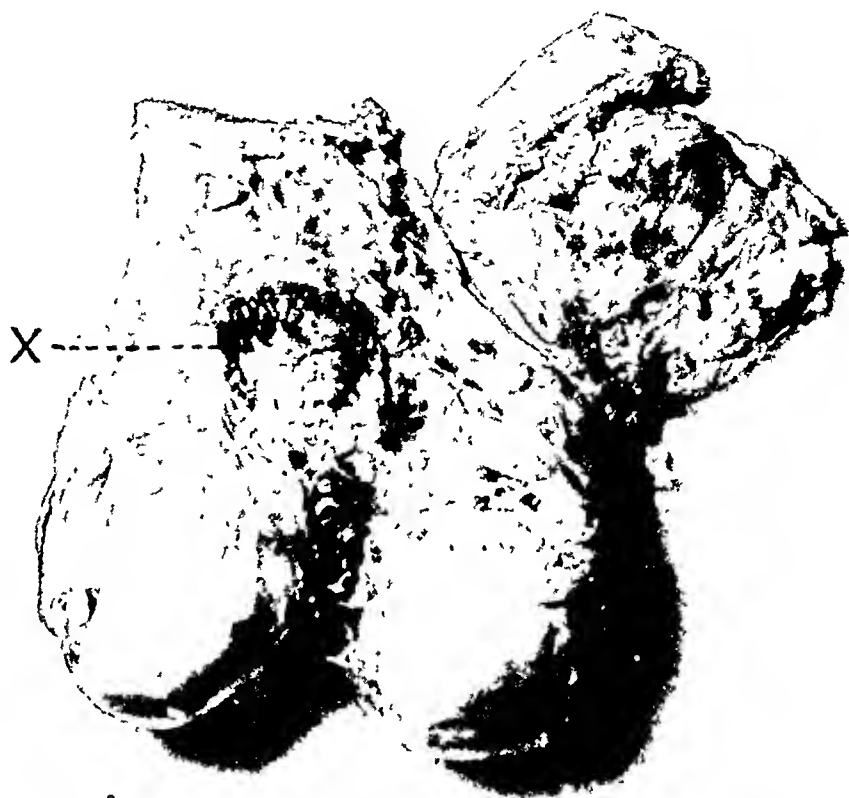


FIG. 12.—Case II. Pathol. No. 34522. Photograph of specimen to show soft part tumor in the popliteal space from perforation of the bone shell. The piece to the right is some muscle and fascia, shecd from the bone, exposing tumor tissue at a.

CASE II.—Pathol. No. 34522, observed January 27, 1924. *Central myxoma of lower end of femur involving shaft and epiphysis. Pure myxoma type.* First, deep X-rays, then amputation. Result, November, 1924, ten months well. This is the first time that I have deliberately made the diagnosis of a possible myxoma and amputated without exploratory incision.

The next most interesting point is that this is the first case in which I have an X-ray of the bone taken before the development of the tumor, and this bone showed evidence of a preëxisting and apparently healed central lesion of the epiphysis.

Previous History.—In November, 1920, three years and ten months ago, this patient, a white female then aged thirty-seven years, came under my observation and was operated upon for a benign tumor of the breast. At that time, because of pain in the right leg in the region of the knee-joint an X-ray was taken (Fig. 8). This was interpreted as a healed and ossified area of tuberculosis or a rare ossified bone cyst. I explored the knee-joint, found a little fluid, but a normal synovial membrane and cartilage. Microscopic sections showed no disease. This patient had been complaining of this joint for ten months, and has been using a cane for four months.

In the *Journal of Radiology* for March, 1920, I recorded a tumor of the lower end of

the femur—as far as I know, the first on record—in which an X-ray made July 1, after an injury was negative. As pain and disability continued further X-ray pictures were taken. Within five weeks an area of bone destruction was found in the external condyle, and the area increased in size up to September first, when the lesion was explored, and amputated on the diagnosis of a central sarcoma of the malignant hemorrhagic-cystic type. This patient is well more than five years, and the diagnosis has been changed by majority vote of Codman's registry, to a benign giant-cell tumor. The interesting part



FIG 13—Case III. Pathol. No. 34618. X-ray December 29, 1923, before operation. Note involvement of shaft and epiphysis; little or no expansion; suggestion of perforation anteriorly. Compare with Fig. 14, after operation.

of the ease, however, was a series of X-rays after the trauma with negative findings. The interesting and unique part of the ease reported here is the X-ray more than three years before, picturing an apparently healed lesion.

Present History.—Whenever this patient wrote me she complained of pain in this knee. We were all inclined to look upon it as neurasthenic. For the past three months the pain has been almost continuous, of greater intensity; there has been some contraction of flexion, and the patient has had difficulty in walking.

Examination.—There is the expression of pain and fear. The involved knee is slightly flexed, there is visible swelling of the lower end of the thigh which, on palpation, is not fluid in the joint, but swelling of the soft parts. The only benign lesion of the bone presenting so much pain and tenderness was a central lesion of the upper end of the humerus in a boy of sixteen, reported in the *Journal of Radiology* for March, 1920. This patient is well after curetting only, and

there is a difference of opinion in Codman's registry, as to whether it should be considered a sarcoma or a variant of the giant-cell tumor.

The point which I wish to emphasize again here is, that extreme pain and tenderness in a bone lesion without fracture and without evidence of inflammation is very suggestive of malignancy.

X-rays.—(Figs. 9 and 10.) The lateral view is better. Both views show a central light area involving shaft and epiphysis, invading the old healed area, recorded in the X-ray (Fig. 8) more than three years ago. The age—over twenty—is against bone cyst; the involvement of the shaft as well as of the epiphysis is against giant-cell tumor. Then we evidently see cortical destruction with a soft-part tumor shadow, outside the cortical layer. There is also practically no expansion. In my experience this X-ray should be looked upon as a malignant tumor, and this case shows that the pure myxoma may give the same X-ray picture as the central myxosarcoma or chondrosarcoma reported and illustrated in the *Journal of Radiology* for March, 1920.

Treatment.—We kept this patient at absolute rest in bed, except when she came to the office for X-ray treatment on crutches. Intensive radiation was given by Dr. Max Kahn from January 7 to 21. Intravenous salvarsan was given by Doctor Collenberg, although the Wassermann was negative.

The X-rays of the chest and all other laboratory examinations were negative. As there was no improvement of the symptoms, amputation was performed July 23, 1924.

Pathology.—Figure 11 pictures the myxomatous tissue in the preserved formalin

BONE TUMORS. MYXOMA

specimens. In the fresh gelatinous material exuded from the cut surface. Observe in the internal condyle the old ossified lesion infiltrated by the tumor. The sharp line of demarcation between the tumor and the marrow and the minute perforations of the cortical shell. Figure 12 at x shows a soft-part tumor outside the bone shell in the popliteal space which we can see in the X-ray in the lateral view.

Microscopically, this is a pure myxoma. As a matter of fact, there is no difference between a pure myxoma and a myxosarcoma. Both seem to have the same tendency to local recurrence, perhaps death from internal metastasis is later in the pure myxoma.

Result in Case II.—October 21, 1924, nine months after operation, the patient is well; no metastasis to the chest.

CASE III.—Pathol. No. 34618. *Central myxoma of lower end of femur.* Operation—curetting with hot soldering irons by Dr. E. W. Rockey of Portland, Oregon. Result: October, 1924, nine months, apparently well.

I am indebted for the record, X-rays and tissue in this case to Dr. E. W. Rockey of Portland, Oregon, and as far as I know, this is the first central myxoma to be attacked primarily with the thermal cautery. The tissues sent to my laboratory from this operation show pure myxoma.

X-rays Before and After Operation.—In this case I have an X-ray dated December 29,

1923, sent me by Doctor Rockey, and an X-ray taken in my office by Doctor Kahn dated August 14, 1924. The interesting question is: Can we tell the shadow of recurrence from the shadow of fibrous healing without ossification?

Let us compare the lateral views before operation (Fig. 13) and eight months after operation (Fig. 14). The chief difference is that the cavity, or light area, in the lower end of the femur and epiphysis is outlined in the picture after operation much more distinctly. In fact, the line of demarcation is as distinct as the cortical layer itself. The picture taken before operation shows a break in the cortical layer at the junction of epiphysis and shaft just beneath the patella.

Nevertheless the cavity which contained the tumor and which was burned out with the soldering irons is still unossified.

The comparison of the antero-posterior views (Fig. 15) before operation and (Fig. 16) after operation, as compared with the normal right leg after operation (Fig. 17), shows that the portion of the cyst extending up into the shaft from the external condyle, suggests ossification. In the pictures before operation (Figs. 13, 14, and 15) the internal condyle is apparently not



FIG. 14.—Case III. Pathol. No. 34618. X-ray August 14, 1924, seven months after operation. Compare with Fig. 13. The central light area has now a more distinct ossified circumscripting shell. The perforation shown in Fig. 13 has ossified. All bones show slight osteoporosis. Compare the patellæ in Figs. 13 and 14.

involved, while after operation there are light shadows suggesting either that the cancellous bone of the internal condyle was removed at the operation, or is the seat of osteoporosis from non-use. In Figs. 14 and 16 the left knee-joint, after operation, shows distinct osteoporosis from non-use, as compared with Figs. 13 and 15 of the affected limb before operation and Fig. 17 of the unaffected limb after operation.

I have studied this question before in a few other cases, and I find that in the majority it is impossible, at first, to distinguish in the X-ray light shadows of definite recurrence from light shadows due to fibrous tissue without bone, or osteoporosis from non-use. I had an opportunity some three years ago to compare two cases of giant-cell tumor in the upper epiphysis of the humerus; both submitted to curetting, one without chemical or thermal cauterization, the other with. At the end of one year, the X-ray shadows are apparently identical. The opening in the bone shell through which curetting had been done appears ossified in the X-ray in both. Yet, after this, recurrence took place in one, the first indication of which was definite local swelling and X-ray showing destruction of the bone shell. I have just seen an X-ray of the other case more than two years after curetting, and the cavity is not yet completely ossified.



FIG 15.—Case III. Pathol. No. 34618 Anteroposterior view. The shadow of the patella overlaps the central light area in the external condyle. The line of demarcation between the tumor shadow and the marrow and shaft shadow above is different from that of any bone cyst or giant-cell tumor. Compare with Fig. 16, after operation

So in this patient of Doctor Rockey this apparent ossification of the bone shell cannot be looked upon as positively excluding recurrence, nor the persistence of the light area as an indication of recurrence. This patient will have to be carefully watched, and if one sees evident destruction of the bone shell, or enlargement of the light shadow, this must be looked upon as a sign of recurrence.

Clinical Note.—This patient was examined in my office August 14, 1924, by Doctors Stewart and Cohn, and X-rays were taken by Doctor Kahn. It is noted that the patient is a white male, aged forty-nine. Two years before the operation in January, 1924, without a definite history of rheumatism and while driving his automobile, his left leg felt cramped and he was conscious of pain in the region of the left knee. As this continued he consulted physicians and was treated for rheumatism. When he came under

Doctor Rockey's care in December, 1923, an X-ray was taken. Doctor Rockey wrote me that from the X-ray he was inclined to the diagnosis of a bone cyst or a giant-cell tumor. The patient complained to him of pain for a period of two years and a recent limp.

Operative Pathology. (Doctor Rockey).—On exploring the bone over the tumor area the shell was so thin that it was broken by a retractor. A window was made in the bone shell and the cavity curetted and *thoroughly burned out with hot soldering irons* of various sizes. The wound healed per primam.

Microscopic Pathology.—Sections sent to me from this tissue showed myxoma.

Discussion.—What shall we do if this tumor recurs? Resection is out of the question. Even with a successful bone transplantation to replace the lower end of the femur, the resultant limb is never as useful. It is therefore a question between further curettings with the soldering irons and amputation. Even before my experience in Case I, I urged amputation in this case of Doctor Rockey. I practised it in Case II without exploration. Now that Doctor Rockey's patient is doing so well, I have no evidence that he runs greater risk of metastasis by further delay if there is a recurrence. However, when there are clinical and X-ray signs of recurrence, the evidence suggests amputation as the operation of choice.

Conclusions in Regard to Central Myxoma.—(September, 1924.) If we leave out the possible central myxoma of the phalanges and metacarpals and consider only the long pipe bones and my one example in the astragalus, the conclusions made in December, 1920, hold good to-day. The only cases of myxoma or myxosarcoma which have been permanently cured, have been subjected to amputation or resection without exploratory incision.

Every myxoma explored has recurred locally, except this Case III of Doctor Rockey, in which the soldering irons were used and in which it is not yet one year since operation.

At the present writing I would choose resection without exploration, if possible, with bone transplantation. This might have been done in



FIG. 16.—Case III. Pathol. No. 34618. X-ray August 14, 1924, after operation. Most marked feature is osteoporosis; some ossification in shaft. No evidence of perforation.



FIG. 17.—Case III. Pathol. No. 34618. X-ray August 14, 1924, of the unaffected right leg, for comparison.

Case I reported here, at the first operation. When resection and bone transplantation would not leave a limb with good function, primary amputation as in Case II, impresses me as the operation of choice.

There will be cases in which resection and amputation can be performed without exploration, because of the localization of the lesion and the character of the X-ray.

Undoubtedly in many cases one must explore. Then one should always

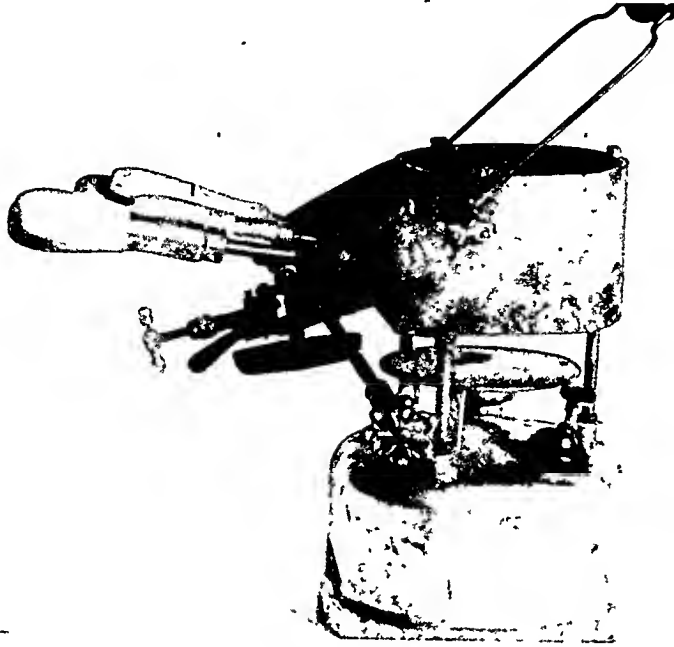


FIG. 18.—Photograph of plumbers' soldering irons and gas furnace.
Total cost \$35.

have ready the cautery, the pure carbolic and alcohol, the fifty per cent. solution of zinc chlorid, and a technician to make a frozen section, and someone who can interpret it under the microscope. From my recent experience in cases in which I have actually seen the gross tissue, or in which I have obtained a clear description by the operator, I am impressed that all of them or the majority of myxomas of the bone, have a definite gross appearance so char-

acteristic that any surgeon who really studies his gross pathology would be able to recognize it at the exploratory incision.

Is Curetting with Thermal Cautery Justified in the Myxoma?—Until Doctor Rockey's patient is followed for some years and shows no evidence of recurrence, one should not employ this method, but at once resect or amputate.

Chondroma.—I have called attention to the tendency of all chondromas to recur if the tumor is explored or removed piecemeal, and a piece of tumor cartilage left in the wound. This tendency is apparently almost as great as in myxoma, but up to the present time, although some of the patients have ultimately lost their limbs and a few have died of the local growth in the region of the vertebræ, none have succumbed to metastasis.

Brief Note on the Literature of Myxoma.—I reviewed the scanty literature in my article in the ANNALS OF SURGERY for December, 1920, but at that time I had not read my colleague, Doctor Cotton's paper, which I would like to briefly abstract here.

In the *American Journal of Röntgenology*, 1918, vol. v, Nos. 2 and 4, Cotton and McCleary, of Baltimore, report an example of a myxoma involv-

ing the shaft of the upper end of the femur, in a female aged thirty-five years. There were two exploratory operations between November, 1915, and the amputation of the hip-joint, November, 1916. In the first paper there are excellent X-rays and photographs of the gross.

In their second report, in the same journal, vol. vi, No. 12, p. 594, the authors report that this patient lived in comfort for two years, then there was evidence of recurrence in the groin and metastasis to the lungs, and death took place in April, 1919, almost four years after the first exploratory incision and two and a half years after the amputation. A marked feature of this case was the extensive involvement of the shaft of the femur, and at time of amputation both a central and periosteal involvement.

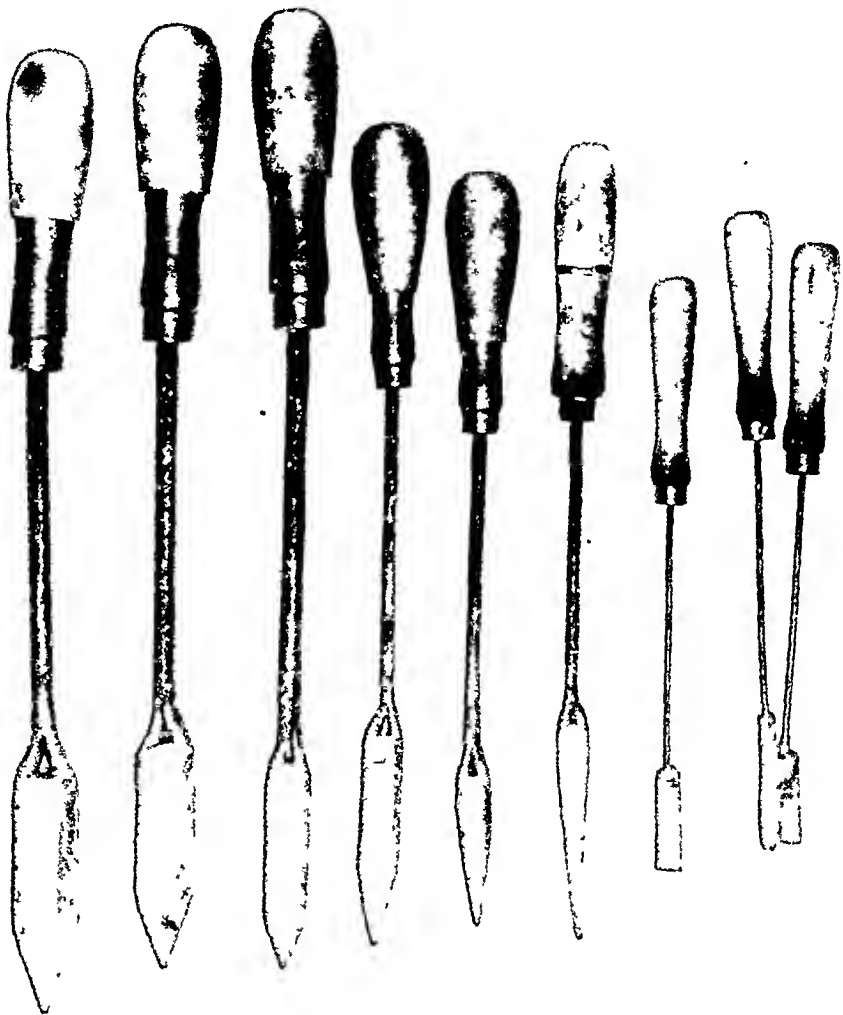


FIG. 19.—The different types of soldering irons.

In the second paper a second case is recorded, involving the shaft of the femur below the trochanter, in a male, aged forty-five years. The duration of the pain before operation was two years. The real lesion was not revealed until the X-ray was taken. An exploratory incision was made and the characteristic features of a myxoma exposed. The tumor was removed with chisel and curette. The wound healed in four months. There were signs of recurrence in six months, then amputation of the hip was performed. The patient succumbed in one year.

CONGENITAL TUMORS OF THE COCCYGEAL REGION

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CONGENITAL tumors of the coccygeal region are of very rare occurrence. Comparatively few cases are reported in the literature. Standard text-books of Surgery and Pathology dismiss the subject with a simple statement that their development is obscure. Different writers reporting isolated cases have assumed different embryological mal-developments as the causative factor in all. The most generally accepted theories as to the causation of such tumors are (G. Herrman and F. Tourneux¹):

1. Herniation of cul-de-sac of terminal meninges secondarily isolated.
2. Osseous and cartilaginous neoplasms from the lower end of the vertebral column.
3. Kystes dermoides formed by abnormal invagination of ectoderm having as a point of origin the so-called coccygeal fossette.
4. Coccygeal gland hypertrophy.
5. Persistence of post-anal gut.

Herrman and Tourneux^{1, 2} offer an embryological explanation for the first of these theories. They describe the development in the embryo of a coccygeal remnant of the chorda dorsalis and trace its development through a series of embryos from the third month to birth. The description briefly is as follows: At the commencement of the third month of intra-uterine life, the medullary tube is prolonged caudally to the extremity of the vertebral column. The terminal segment corresponding to the last coccygeal vertebra becomes adherent to the skin. At the end of the third month the vertebral column begins to develop more rapidly than the spinal cord and meninges, thus pulling the medullary tube up into the vertebral canal, but leaving it attached to the skin. This results in an inequality and angulation of the caudal portion of the medullary tube, forming two branches: the "segment coccygiens direct" and the "segment coccygiens reflechi." During the fourth month the segment direct disappears. The segment reflechi persists and having undergone various modifications is found at birth. It is entirely separated from the remainder of the developing nervous system by the end of the fifth month. The structure is described as being roughly spherical and lined partly with stratified and partly with polyhedral columnar epithelium which retains its earliest embryonal characteristics. It is found entirely outside the vertebral canal and lies just anterior to the tip of the coccyx. A few polycystic tumors of the coccygeal region have been reported as present at birth. Two of these are reported by Herrman and Tourneux,^{1, 2} and a few others have been reported by other authors. All of these probably developed from the "vestiges coccygiens" by which term the persistent "segment coccygiens reflechi" is known at birth. These tumors have been rather loosely called

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neurenteric cysts without much understanding of the embryological factors involved.

Osseous and cartilaginous neoplasms from the lower end of the vertebral column undoubtedly could occur, but we were unable to find any direct references in the literature to such tumors as being present at birth.

Dermoid cysts of the coccygeal region, the so-called pilonidal cysts, usually develop later in life. They develop as painful masses which are usually small and are found about the tip of the coccyx. They are true dermoids containing hair, subaceous material, etc., and are occasionally malignant. They very often



FIG. 1.—Coccygeal cyst.

drain to the surface through a small sinus. Their development from ectodermal infolding from the ectoderm originally found attached to the tip of the coccyx, is comprehensively described by Navarre.³

Coccygeal gland hypertrophy was formerly thought to be a causative factor in a large number of congenital coccygeal tumors. At the present time this is not so generally believed, especially since the report of Vallois and Peyron⁴ on the development of the coccygeal gland. These men, after an exhaustive study of the subject, come to the conclusion that the coccygeal gland develops from a plexus of blood-vessels derived from embryonic blood vascular channels corresponding to the caudal artery and vein of lower mammals. It is therefore strictly a blood vascular structure. At least one case which has been reported as arising from the coccygeal gland and described as being composed of epithelial elements, is open to a slight suspicion of having been derived from the vestiges coccygiens. (Burns.⁵)

SCHMIDT⁶ described a tumor of the coccygeal region in an eight months' foetus which had been preserved in the Heidelberg Museum as a tumor arising from the coccygeal body. This tumor was quite large and was covered posteriorly by the skin and portions of the glutei. The sphincter ani was drawn backward by the mass and the anus stood wide open. It also extended well up into the pelvis. This tumor was polycystic and contained many small semi-solid connective tissue nodules. The tissues of the foetus between the tip of the coccyx and tumor were sectioned serially and the coccygeal body was found in its normal situation and not affected by the tumor. On

account of this and other similar instances with which he was acquainted, Schmidt felt that the coccygeal body probably never gives rise to any tumor formation.

MIDDLEBORP⁷ reported a case of a tumor which undoubtedly arose from the post anal gut. This tumor was removed at the age of one year, but had been present since birth. It was a small rounded semi-solid mass which extended from the sacrum anteriorly almost to the symphysis, practically covering the external genitals and the anus. There were two fistulous openings in it, from which discharged at times material resembling fecal matter. The baby was healthy in every way and its bowels had moved normally at all times. Dissection of the tumor showed that it had no connection with the rectum or sigmoid. Histological examination showed that it consisted largely of fatty tissue in which were imbedded tubules identical in structure with small intestine.



FIG. 2.—Showing result of operation for removal of coccygeal cyst.

Histologically all the layers of intestine, except the serosa, were found. He was not sure whether it represented a tumor arising from the post-anal gut or whether it represented a parasitic twin, but inclined to the former opinion.

From the foregoing brief résumé it can be seen that congenital tumors of the coccygeal region have been reported as arising from various causes. We wish to report a case of a congenital cystic tumor of the coccygeal region which seems to fall into that class of tumors, which according to Tournoux and Herrman,^{1, 2} are derived from the vestige coccygiens. The case described is a single unilocular cystic tumor. Very few unilocular cysts have been reported. In fact, we were unable to find an original report of any. Several multilocular cysts of similar character have been reported however. Fowler,⁸ in 1885, reported a multilocular cyst containing some semi-solid masses and gave a review of the literature up to that time. Huber,⁹ in 1892, reported another, and a few others are on record.

Case Report.—Magee Hospital No. 3323. The baby, Italian, full-term female, was born February 1, 1924. Mother had previously borne seven normal children. Duration of labor 8 hours and 55 minutes. The delivery of head and shoulders was normal. The delivery of the rest of the body was delayed for several minutes by the presence of a large mass in the coccygeal region. This mass was almost as large as the baby's

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head. The attending physician diagnosed the condition as a low spina bifida. The infant was fully developed and normal in every other way. Was admitted to the Elizabeth Steel Magee Hospital, February 7, 1924, service of Dr. B. Z. Cashman. General physical examination was entirely negative. The tumor mass was nearly as large as the baby's head and apparently covered only with skin. It fluctuated and was quite evidently cystic. The anus was dislocated downward and backward and stood wide open. Palpation of the tumor caused the infant no apparent discomfort. Rectal examination showed the absence of bony structures between the rectum and the tumor. Over the highest point of its surface, there were three somewhat widely dilated veins and the skin at this point was quite thin. The accompanying photograph (Fig. 1) gives an excellent idea of the appearance of the tumor. The mass increased somewhat in size during the eight days it was kept under observation prior to operation. X-ray examination gave no assistance in diagnosis. Plate showed a normal pelvis. On account of the increase in size of the mass, it was felt that some effort should be made to remove it, even though an exact diagnosis as to its character could not be made.

Operation.—February 15, 1924, Dr. B. Z. Cashman. Baby was placed on its right side, skin was prepared with alcohol, Harrington solution and picric acid. The skin and subcutaneous tissue overlying the mass were infiltrated with novocaine. Two incisions were made laterally over the mass in an elliptical manner and joined at their extremities. The wall of the mass was for the most part, just beneath the skin. The upper end was beneath the glutei, and dipped beneath the tip of the coccyx and extended upward anterior to the coccyx for a distance of about 2 cm. The mass was easily dissected free from surrounding structures, except when the median line was approached toward the tip of the coccyx. Its only firm attachment was anterior to the tip of the coccyx. Anteriorly it was separated from the rectum by a firm fascial layer. The external sphincter ani muscle was found to be pulled downward and backward over the cyst wall. When it was dissected free from the cyst wall it was seen to immediately assume the normal position and the anus closed. After the cyst was entirely removed the wound was closed with interrupted silkworm gut sutures.

The mass removed was seen to be a thin-walled cyst which contained amber-colored fluid with a specific gravity of 1.014. Microscopic examination of the centrifuged fluid showed the presence of a few cells which were apparently epithelial in character. Pathological examination showed the sac to be largely composed of connective tissue. The lining membrane had been evidently largely destroyed by the accumulated fluid, but in one or two places a lining of flattened simple epithelium was found and in other places the lining was composed of stratified columnar epithelium, thus again corresponding to the cases reported by Herrman and Tournoux^{1,2} as being derived from the vestiges coccygiens.

The baby made an uneventful recovery. The wound healed by first intention. X-ray examination of the baby after the wound was healed disclosed no abnormalities of the pelvic girdle, sacrum or coccyx. The anus was in normal position and the sphincter apparently functioning. Except for the scar and a certain amount of redundant tissue about the lower end of the scar, the baby was normal in every way when discharged from the hospital, March 14, 1924.

I wish to express my thanks to Dr. B. Z. Cashman for his kindness in permitting me to report this case, and to Dr. Davenport Hooker, Professor of Anatomy in the School of Medicine, University of Pittsburgh, for his great assistance in the preparation of this report.

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MELANOMA OF THE NAIL BED

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THE subject of melanotic tumors occupies a conspicuous place in medical literature and is one which never ceases to be of the greatest interest. The admission to the Massachusetts General Hospital of a rather unusual case of melanotic malignancy, which was characterized by its originating in the nail matrix following trauma, and by its close resemblance to the ordinary paronychia, prompted a search of the literature for reports of similar cases. The examination of the literature showed that this particular type of case is one not frequently encountered, or not recognized as being malignant. The literature on the subject is admirably reviewed by A. E. Hertzler¹ in a rather recent article, in which he reports seventeen cases in all, including two of his own. As a survey of the hospital records netted only two cases in addition to the one mentioned above, it seemed advisable to report all three as exemplifying a rather unusual condition.

In reporting a number of these cases, Hutchinson² wrote under the title of "Melanotic Whitlow," although he recognized the fact that the condition was malignant. "There is a rare form of disease of the nail bed which is malignant, and usually takes the type of melanotic sarcoma. It is generally attributed in the first instance to injury, and its diagnosis is always missed in the early stages. Because it resembles whitlow, and is usually so named at first, I prefer to give it that name. It is, however, from the beginning malignant. Careful observation will find at the edge of the inflamed nail a little border of coal-black color, and this, however, slightly marked, must be allowed to make the diagnosis." Hertzler¹ in the report noted above selects the title "Melanoblastoma of the Nail Bed," which is excellent, as it describes adequately, yet tersely, the cases in question. In the present instance the term "melanoma" is preferred. A discussion of the connective tissue or epithelial origin of these tumors will not be undertaken here, as it is beyond the scope of this communication, which aims only to call attention to the characteristic features of these cases. These can best be presented by a brief consideration of the case histories.

CASE I.—Hospital No. E. S. 750-131; M. C., age forty-two, single, white female, seamstress, was first admitted to the out-patient department, August 10, 1911. Her previous history was negative. The onset of the illness was February, 1911, six months before admission, when she first noticed a "crack" in the nail of her left thumb, which subsequently became infected. One-half of the nail excised and curettage done by her physician. The wound failed to heal and four weeks after the above treatment, "black specks" appeared in the unhealed area. On August 11, the note reads, "On the left thumb is a large indolent ulcer involving about one-half of the nail bed." At this time

there was no pigmentation, the ulcerated area was covered with clean granulations, and there was nothing, aside from the chronicity of the lesion, to suggest that it was not due to an infection of the nail bed, resulting in partial loss of the nail. On August 14 a small section was excised for microscopical examination which showed indications of "new growth." September 11 the thumb was amputated at the middle of the proximal phalanx. Microscopic examination of the specimen removed showed the characteristic large irregular cells infiltrating the tissues immediately below the epithelium together with varying amounts of pigment. (Fig. 1.)

The wound healed satisfactorily without any signs of recurrence. November 28, 1911,



FIG. 1.—Case I. Path. No. 11-12-3. (Photomicrograph by Dr. A. E. Steele.) Photomicrograph of original tumor, showing normal epithelium with extensive infiltration of underlying tissue with tumor cells.

she again visited the out-patient department because of a swelling in the axilla and was immediately admitted to the wards. Physical examination at this time showed a poorly nourished woman, with a palpable gland in the left axilla, one inch in diameter, and two palpable glands, pea-size, in the left supraclavicular region. Chest negative; liver and spleen not palpable. Left thumb amputated just posterior to the distal joint. Operation by Dr. F. B. Harrington, consisting of dissection of glandular and fatty tissue in the supraclavicular triangle and axillary dissection was performed. The pathological report showed that only part of the glands were involved, the one large axillary gland on section being found to have undergone cystic degeneration, with the accumulation of a thin, reddish, hemorrhagic fluid. Microscopical examination of the involved glands showed "new growth" of irregular cells with

eccentric nuclei. No pigment was found in the specimens examined. (Fig. 2.)

The post-operative course in the hospital was uneventful. She remained well without recurrence until July, 1912, eight months later, at which time the left elbow began to swell, with subsequent development of pain. The condition of the elbow became progressively worse and she was again admitted to the hospital, October 11, 1912, eleven months after her first admission.

At this time she presented the picture of one suffering from malignant disease. She had a persistent unproductive cough, weakness and was markedly undernourished. Abdomen negative. Chest negative. The left elbow showed a "round, deep purple tumor about five inches in diameter, chiefly on the inner side of the joint which was fixed at a right angle." (Fig. 3.) The whole tumor was extremely tender on palpation. The axilla showed the scar of the previous operation with a small hard, firm nodule the size of an olive in the anterior axillary fold. On October 14, amputation at the shoulder joint was performed by Dr. F. B. Harrington. October 27, a small "grape-size" nodule appeared

in the skin of the abdomen just below the umbilicus. This was excised and the pathological report was "Melanotic Sarcoma." On October 20, there was observed a similar nodule in the right infraclavicular region, while on November 5, a third was noted near the left anterior spine of the ilium. It being evident that the case was hopeless, the patient was discharged with the diagnosis "Melanotic Sarcoma with Metastases." The patient died January 8, 1913, two months after discharge and approximately three years after the onset of the disease, and thirteen months after her first admission.

CASE II.—Hospital No. E. S. 237592; T. J. C., aged thirty-six, white, male, engineer, admitted to the wards July 10, 1920, complaining of "a sore on the right great toe." His previous history was negative. The onset of the present illness was two years before admission when, following slight trauma, the patient lost the nail of his right great toe. The lesion was cauterized frequently, but refused to heal, resisting all treatment. During the six months before admission, the granulations grew rapidly, in spite of frequent cauterization, so that at the time of admission the lesion had assumed all the characteristics of a tumor. On physical examination the chest and abdomen were negative. In the right groin there was a hard palpable gland the size of an almond. The right great toe showed the nail to be missing,



FIG. 2.—Case I. Path. No. 11-12-3. (Photomicrograph by Dr. A. E. Steele.) Photomicrograph of lymph gland removed from axilla at second operation, showing invasion of gland by "new growth," composed of irregular cells with eccentric nuclei.



FIG. 3.—Case I. Photograph of left arm, showing recurrence at the elbow, eleven months after excision of axillary glands.

The patient was discharged on August 3rd, after an uneventful recovery. Eight months later, March 26, 1921, the patient was again admitted to the hospital

being replaced by a tumor about the size of a walnut, irregular, rather firm, dark red or purple in color, and quite vascular. (Fig. 4.) There was considerable moisture and serous discharge on its surface. On July 12, amputation of the toe at the metatarsal phalangeal joint and dissection of the groin were performed by Dr. Beth Vincent. The pathological report on the tissue removed was "melanotic sarcoma with metastases to the inguinal

with the diagnosis of "Metastatic Melanotic Sarcoma of the Brain," based on history and physical findings. He had had frontal headaches of increasing frequency and severity, some vomiting, gradually failing memory, and some speech difficulty. On physical examination the important points were, beginning bilateral choked discs, nystagmus on looking to right, paralysis of the left side of the face, some ataxia, marked memory defect, mental retardation. It being apparent that any operative procedure was hopeless, the patient was discharged April 2, 1921, and died five weeks later, approximately three years after onset and ten months after his first admission.

CASE III.—Hospital No. 258579, L. S., age seventy-two, white, female, widow, admitted to the out-patient department, November 4, 1922, complaining of "a sore on the great toe." Her previous history was negative. She dated the onset of the present illness

five years before admission when she "bruised" her right great toe. Except for slight pain at the time, the patient experienced no discomfort and thought no more about the incident. Four days later, quite by accident, the patient discovered a small black area "like a blood blister" under the inner corner of the injured nail. This "spot" remained unchanged for one year. However, during the next four years, it increased slightly in size. When she presented herself to the out-patient department, the lesion was restricted to the area normally covered by the nail. The note at this time reads "exuberant granulations, bleeding readily, over the area ordinarily covered by the nail. A few shreds of nail about the periphery. X-ray negative except for atrophy of

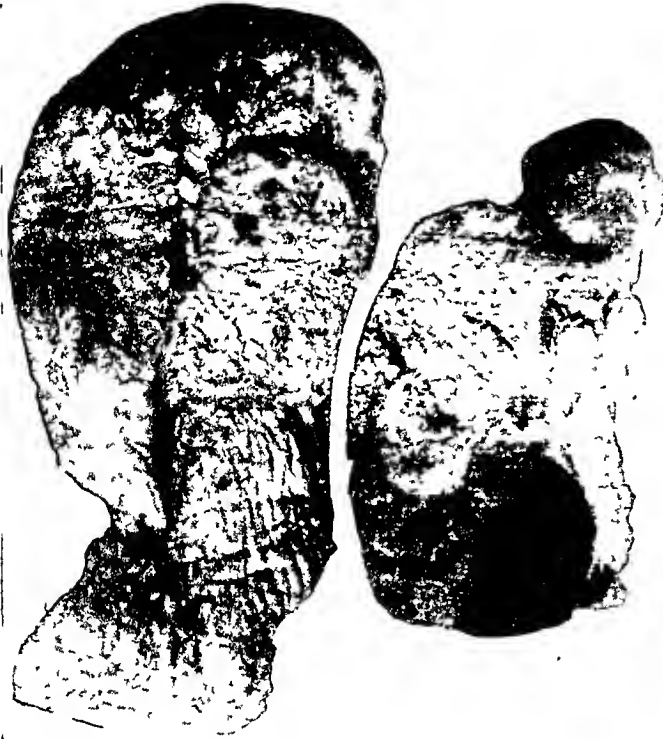


FIG. 4 —Case II. Photograph of specimen removed at operation, showing tumor involving matrix of the nail which has extended beyond the limits of the nail bed. To the right, cross-section of lymph gland removed from the groin. Note areas of pigmentation.

bone of great toe." The patient was sent home with instructions to return immediately if the lesion progressed noticeably. Six months later it suddenly began to grow rapidly. Contrary to instructions she did not return to the hospital immediately, so that at the time of admission to the wards, September 26, 1923, the toe was involved down to the middle of the first phalanx. It is interesting to note that although there was at this time a perfectly definite tumor, the condition was incorrectly diagnosed in the out-patient department, the patient being referred to the house with the diagnosis of "gangrene of the right toe."

Physical examination on admission showed the following: an obese elderly woman in apparent good health. Chest negative. X-rays negative for metastases. Abdomen negative. In the right inguinal region were several enlarged glands, almond-size, hard and firm. There was also a similar gland somewhat larger in the popliteal space. The right great toe showed a large irregular "bossy" tumor extending to the metatarso-phalangeal joint on the anterior aspect and to the midpoint of the proximal phalanx on the plantar surface. The toe nail was missing. (Fig. 5.)

The surface of the tumor was irregular, deep purple in color, with here and there

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small areas deep black in color scattered throughout. There was considerable serous discharge. On palpation it was very hard, firm, "cartilaginous-like" and somewhat tender. A diagnosis of malignancy was made and September 28 amputation at the metatarso-phalangeal joint was performed by Dr. E. P. Richardson. The pathological report on this tumor was "Melanotic Sarcoma." The regional glands were not removed because their situation and extent were such that any interference with them seemed likely to produce a more rapidly fatal dissemination. The wound healed per primum and the patient discharged October 15 after an uneventful convalescence. Examination of the patient three months after discharge revealed extensive metastases as evidenced by large palpable



FIG. 5.—Case III. Photograph of right foot showing tumor involving the great toe.

masses in the abdomen, marked increase in the size of the inguinal glands and considerable oedema of the legs.

The foregoing cases are all very similar to other cases reported and consequently serve as excellent examples. In each instance it will be noted that trauma to the nail antedates the subsequent development of the lesions, which is true in the majority of cases reported, although it is doubtful whether this is more than a coincidence or a stimulus to growth of a preëxisting lesion. Furthermore, we are dealing with a condition characterized at its onset by a period of extremely slow development. The duration of the period of quiescence, as it were, varies tremendously, as can be seen by comparison of Case I and Case III, the average being four or five years, although Boyer³ reported a case in which the lesions remained stationary for twenty-eight years. On the contrary, once the initial lesion progresses noticeably, a rapidly fatal course is inevitable. Case I exemplifies the astonishing rapidity with which metastases occur, death taking place in this instance within three years after the trauma, and eleven months after the thumb first began to cause symptoms.

By far the greater majority of reported cases occurred in individuals over fifty years of age. In this respect Case I, and especially Case II, are a little unusual. Apparently males and females are affected about equally.

Clinically in its early stages, the lesion is apparently a paronychia, its earliest appearance being that of a small hæmatoma beneath the nail. Unlike the paronychia, this lesion gradually increases in size despite treatment, ulcerates and destroys the nail slowly until at length the latter is entirely lost. For the lesion to develop to this point requires a period of time varying from a few months to several years. To the casual observer, it now appears as red or purple exuberant granulations which bleed rather freely. However, careful observation will usually reveal small areas of black pigment either scattered through the lesion or around its border. The presence of pigment is pathognomonic, and furnishes the key to the diagnosis at this point. Following this stage in its development, it seems to attain some stimulus which causes it to progress with extraordinary rapidity and in a very short time it is quite evident that one is dealing with a new growth, as evidenced by the local tumor and enlargement of regional glands. From this point its progress is rapidly fatal, extensive metastases taking place throughout the body. Except for the inconvenience caused by the local lesion, the patient is comparatively free from symptoms. However, in some cases, pain and local tenderness may be rather severe during the later stages of its development, although this is by no means a constant feature.

Pathology.—With the exception of Case I, it would seem that these cases came into the hospital relatively late in the course of the disease. Both Case II and Case III presented easily recognizable tumors, consequently the diagnosis should have been obvious. However, Case III, in which the lesion was the most advanced, was admitted with the diagnosis of “gangrene of the toe.” On the other hand, the lesion in Case I showed no characteristic pigmentation, but the duration of the condition was such that suspicion of new growth was aroused and a specimen excised for diagnosis. This represents the course which should be taken in a chronic progressive ulceration of the nail bed. It is desirable to obtain if possible an immediate diagnosis of the specimen, so that, if necessary, amputation can be carried out at once.

In the cases showing definite tumor mass, the latter was hard, irregular, deep red or purple in color, with here and there small areas deeply pigmented. (Figs. 4 and 5.) On section these specimens showed varying amounts of pigment. Case II showed a deep black outer zone, with a moist grayish base, without any apparent involvement of the underlying soft tissue. On the other hand, section of the specimen in Case III disclosed a uniformly brownish-black tumor which completely filled the soft parts, having destroyed the nail.

In the cases in which the region glands were excised, Case I and Case II, these were found to be firmly matted together. The individual nodes were markedly enlarged, hard and firm, presenting on section in both cases varying amounts of pigmentation. (Fig. 4.)

Microscopically these cases were quite similar and characteristic. The original lesion in each case was composed of large, irregular cells, showing all degrees of transition from round to spindle-shape, with large eccentric nuclei

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(Figs. 1 and 6), with an indistinct alveolar arrangement. In many instances, these cells were in close association with the thin-walled blood-vessels. In two cases, Case I and Case II, mitotic figures were very numerous. Examination of sections of lymph-glands removed showed practically the same picture except that the pseudo-alveolar arrangement was a less prominent feature. On the other hand, the shape of the cells did not differ materially from that seen in the primary tumor. (Figs. 2 and 7.) However, Hertzler and Gibson,⁴ in their cases, found that the primary cells were spindle-shaped while in the metastases the prevailing cells in these cases is very interesting. Hutchinson⁵

The distribution of pigment in these cases is very interesting. Hutchinson⁵ called attention to many points concerning the distribution of pigment in cases of melanosis. "This mixture of colored and uncolored growth in melanotic sarcoma is, of course, common in all parts, but in none is it, I think, so marked as in the proximity of the nails." "When melanosis fungates and when it affects the glands, we must not expect the larger growths to be of black color. The power of producing black pigment appears to be, in most persons, very limited. The original growth beginning it may be in the site of the eye is coal black, but the later and larger growths are white, or show only here and there a pigmented streak." In the above cases, Case II and Case III, there was extensive pigmentation in the original growths. In Case I, in which glands were removed from the axilla at the second operation, they showed no pigmentation, although they were extensively infiltrated with tumor cells. (Fig. 2.) However, in the glands removed at the third operation, and in those removed from the groin in Case II, there was found considerable pigment both grossly and microscopically. (Figs. 4 and 7.) The extent of the glandular involvement appears in some cases to be curiously dependent upon the amount of pigmentation in the original tumor. In those cases in which the latter is only partially pigmented, as in the above cases, the tendency to pigment formation in glandular metastases is most

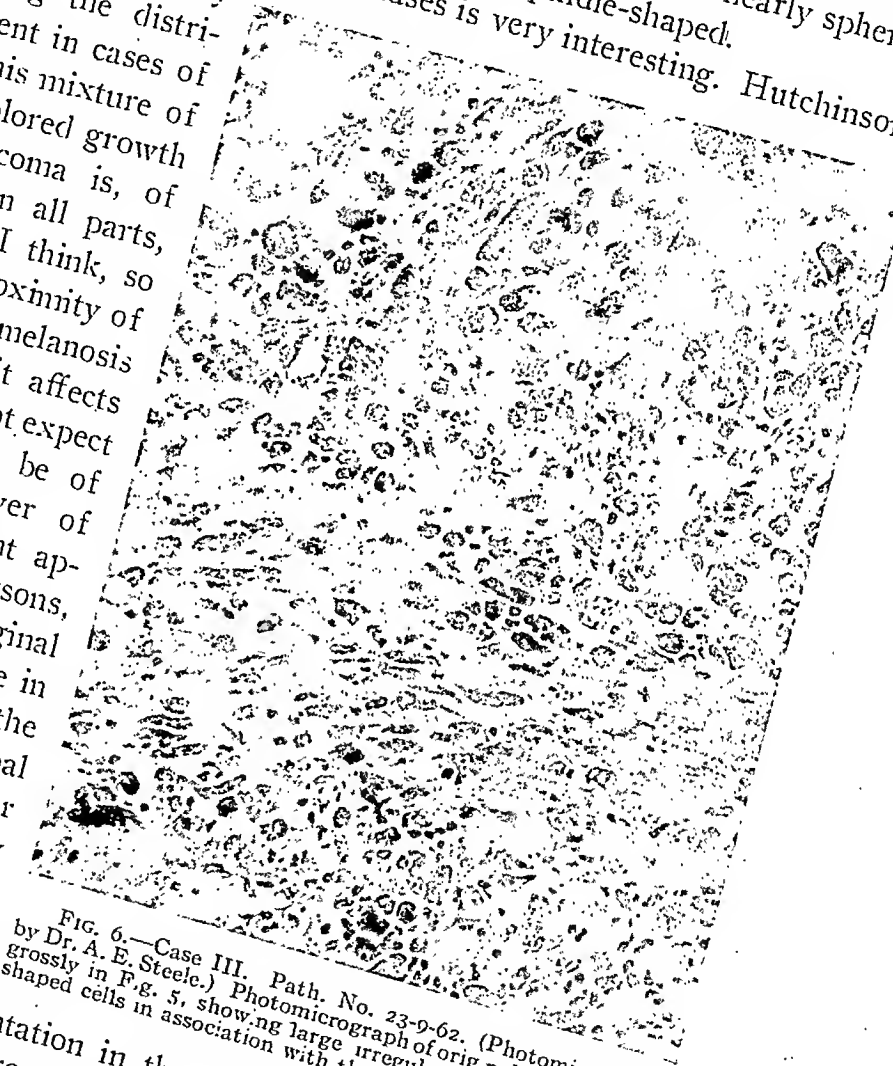


FIG. 6.—Case III. Path. No. 23-9-62. (Photomicrograph by Dr. A. E. Steele.) Photomicrograph of original tumor, shown grossly in Fig. 5, showing large irregular round and spindle-shaped cells in association with thin-walled blood-vessels.

marked. On the other hand, there are cases reported^{6,7} which are very interesting from the standpoint of metastases; where the initial tumor is of "utter blackness" and "the restriction of the growth during its earlier periods of its secondary reproduction, is, in a remarkable manner, restricted to the limb in which the disease originated." In these cases the lymphatic trunks of the extremity are found to be extensively involved appearing as beaded cords of coal black pigment, to the exclusion of glandular involvement.

Diagnosis and Treatment.—It is obvious that one of the greatest difficulties encountered in these cases is that of making an early diagnosis. It is impossible to say what the ultimate result would be if surgery were given



FIG. 7.—Case II. Path. No. 23-9-62. (Photomicrograph by Dr. A. E. Steele.) Photomicrograph of lymph gland shown grossly in Fig. 4, contrasting tumor cells with lymphocytes. Note intra and extracellular pigment granules.

the benefit of an early diagnosis, in accomplishing which several points are helpful. Careful and painstaking examination of the lesion is paramount, for the essential points of diagnosis are so delicate that they can be readily overlooked. Attention has been directed repeatedly to the fact, that although at first glance these lesions appeared to be simple ulcers, the surface epithelium is not completely destroyed.^{1, 8, 9} The pigment often appears early in these cases in the form of "black specks" scattered throughout, or as a black border surrounding the lesion as pointed out by Hutchinson² and Hertzler.¹ This feature when present is extremely important, although in many instances its recognition is

difficult. "To make the diagnosis at these stages, it is necessary to look carefully at the skin near the margin of the fungus. Here a little colored border may often be found, looking as if the lunar caustic had been applied, which tells the tale."² "It needs sometimes the eye of faith to recognize the narrow band of black which borders the inflamed part."⁵ However, when the pigment is once discovered, the diagnosis is made. The presence of "black specks" or a "black border" is the key to the early diagnosis. Hence the importance of careful, painstaking examination of the lesion cannot be overemphasized. However, many cases show no pigment until relatively late in the progress of the disease.

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Consequently chronic ulcerative lesions of the nail bed in elderly persons which do not respond to adequate treatment should be regarded with suspicion. In such cases, excision of a small amount of tissue for frozen section is indicated, but only if preparations are complete to perform immediately an amputation in case the diagnosis of malignancy is confirmed.

The treatment of these cases is radical excision. This means amputation of the digit and complete resection of regional glands as a minimum. The consensus of opinion is that Röntgen-rays and radium therapy are ineffective. The prognosis depends on early diagnosis, and is usually extremely poor when the lesion is finally recognized and hopeless when metastases occur.

SUMMARY

- (1) Melanoma of the nail bed may occur.
- (2) The condition resembles paronychia, but is chronic and shows pigmentation.
- (3) Occasional cases may occur without obvious pigmentation.
- (4) The diagnosis is ordinarily made late with the result that treatment is hopeless.
- (5) This condition must be considered in all chronic conditions of the nail bed.
- (6) Diagnosis should be confirmed by excision and microscopic examination of tissue, followed by immediate operation.
- (7) In the three cases reported, the diagnosis was made too late to prevent death from general metastases.

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FRACTURES OF THE SHAFT OF THE FEMUR

TREATMENT BY MEANS OF BALANCED TRACTION
ANALYSIS OF IMMEDIATE RESULTS IN FORTY CASES

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THE ultimate displacement of the fragments in a fracture of the femoral shaft is due almost entirely to the pull of the muscles which span the line of

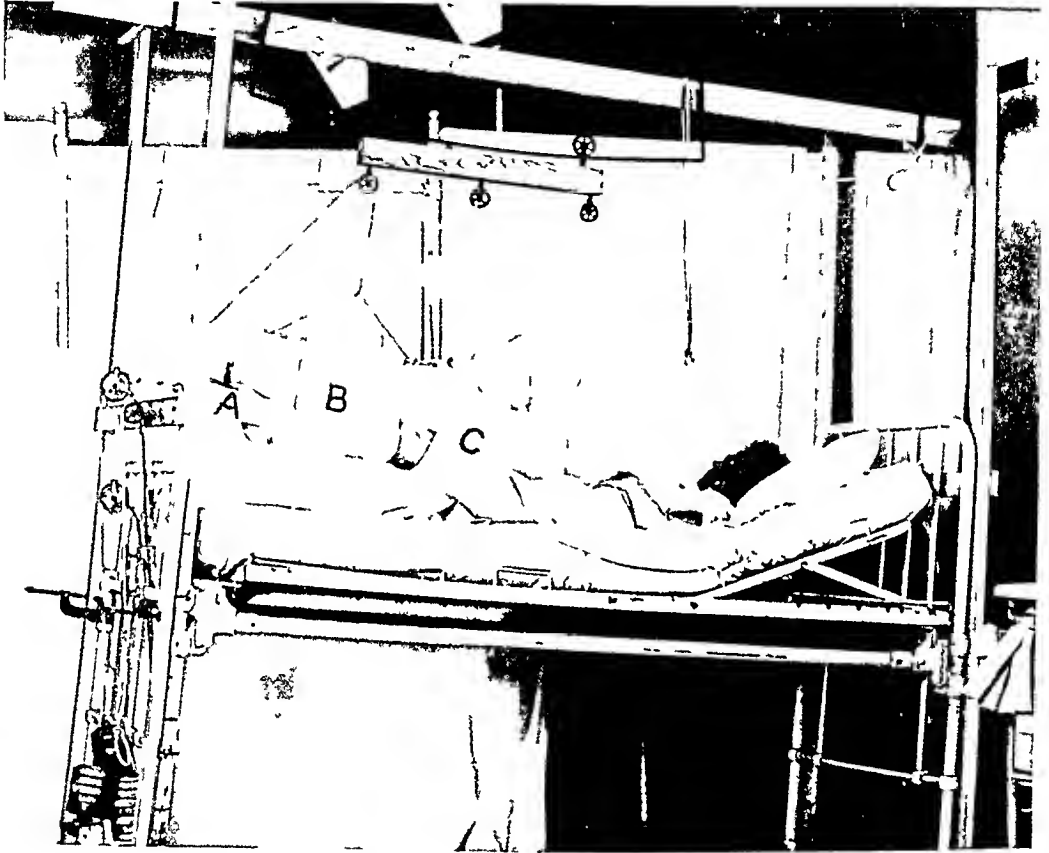


FIG 1—H 5117. A R., age 48. Comminuted fracture of lower third of left femur involving the joint with associated hæmarthrosis. A, traction straps. B, leg sling. C, thigh sling. Appliance to prevent foot drop has been omitted for a few days to obtain better relaxation of the gastrocnemius.

fracture. The violence, direct or indirect, which produces the break ceases to act as soon as the leg is placed at rest and the problem of reducing or fixing the fracture becomes largely one of the mechanics of muscle pulls. Could the force and direction of these muscle pulls be exactly counterbalanced, the fracture should theoretically reduce itself; and if the apparatus is so arranged as to exert a constant effect upon the fragments, the reduction should be maintained even though the patient moves about to some extent in bed.

The following is a preliminary report of the salient features of a method which embodies the above considerations. It has been successfully used in eleven cases of fracture of the femoral shaft which have been admitted to the surgical service of the Cincinnati General Hospital since July, 1923.

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Traction, to be most efficient, should be applied with the limb in the position which puts the greatest number of muscles in a state of physiological rest. For the leg this position has long (Potts, 1768; Malgaigne, 1839²) been known to be one of semiflexion at both hip and knee. Traction in this position may be obtained by means of ice tongs or the Stinemann pin, but both methods have given rise to complications such as infection of the knee-joint or atrophy of the bone about the metal. In certain fractures, particularly in those of the middle third of the femur, the Hodgkin splint is efficacious but in this method, traction is exerted on the leg as a whole and cannot well be adapted to the particular needs of certain fractures, *vis.*: those of the upper and lower third.

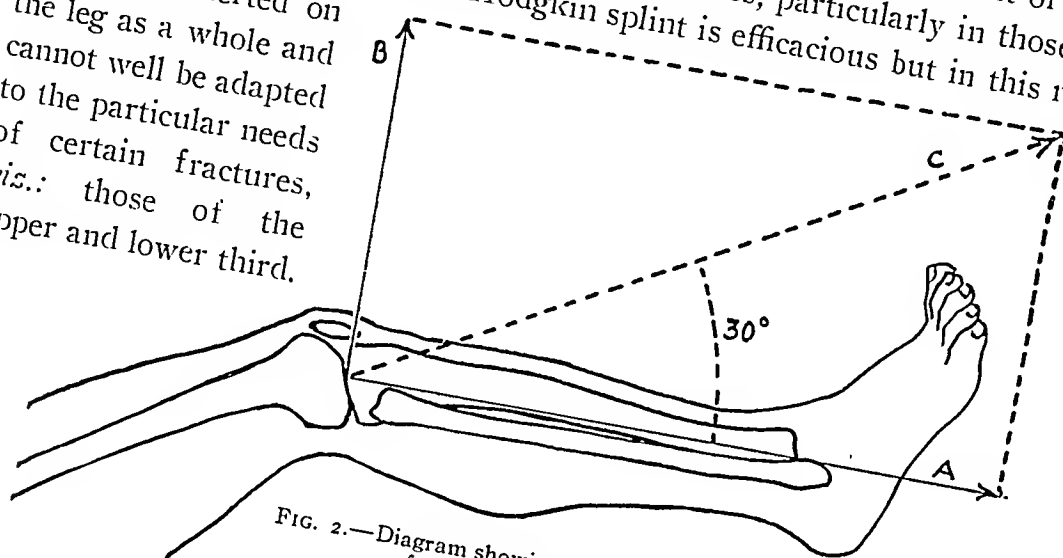


FIG. 2.—Diagram showing the direction and force of the resultant of the pulls on the traction straps and sling.

We have considered each fracture as a specific problem in the mechanics of muscle pulls and by a combination of skin traction and counter-traction have attempted to counteract the force and the direction of these pulls.

Method.—The leg is carefully shaved and cleaned with alcohol and either the malleoli protected with pads. Traction straps of ZnO adhesive plaster are then applied to the leg below the knee (Fig. 1, A) and fastened to a wooden spreader provided with a cord which runs over a pulley at the foot of the bed. To this cord is attached a weight which varies according to the age and the physical condition of the patient, but is usually from twenty to twenty-four pounds in a robust individual. A sling (Fig. 1, B) which extends from a point just below the head of the fibula to the malleoli is then placed about the calf of the leg and provided with a rod from which a cord passes through the lower pulley of the "traveller" of the fracture frame and over another at the foot of the bed. The system is so arranged as to make the pull on the sling act at right angles to the pull on the traction straps and with one-half its force.

The resultant of these two forces acts at an angle of 30° with the horizontal—or directly in line with the axis of the femur with the leg in semiflexion—and is equal to the square root of the sum of the squares of the two forces (Fig. 2, A and B). If equal amounts of weight be attached to the sling and traction straps, 45° of flexion is obtained and the resultant is equal to

the square root of $2A^2$. Thus by varying the amounts of weight we are able to vary the force of the pull and the degree of flexion to suit the requirements of a given fracture. When the upper fragment is abducted, as in many fractures of the upper third, the traction is applied with the leg in about 30 degrees of abduction.

Another sling (Fig. 1, C) is placed about the thigh, from which a cord runs through the uppermost pulley of the traveller and over the head of the

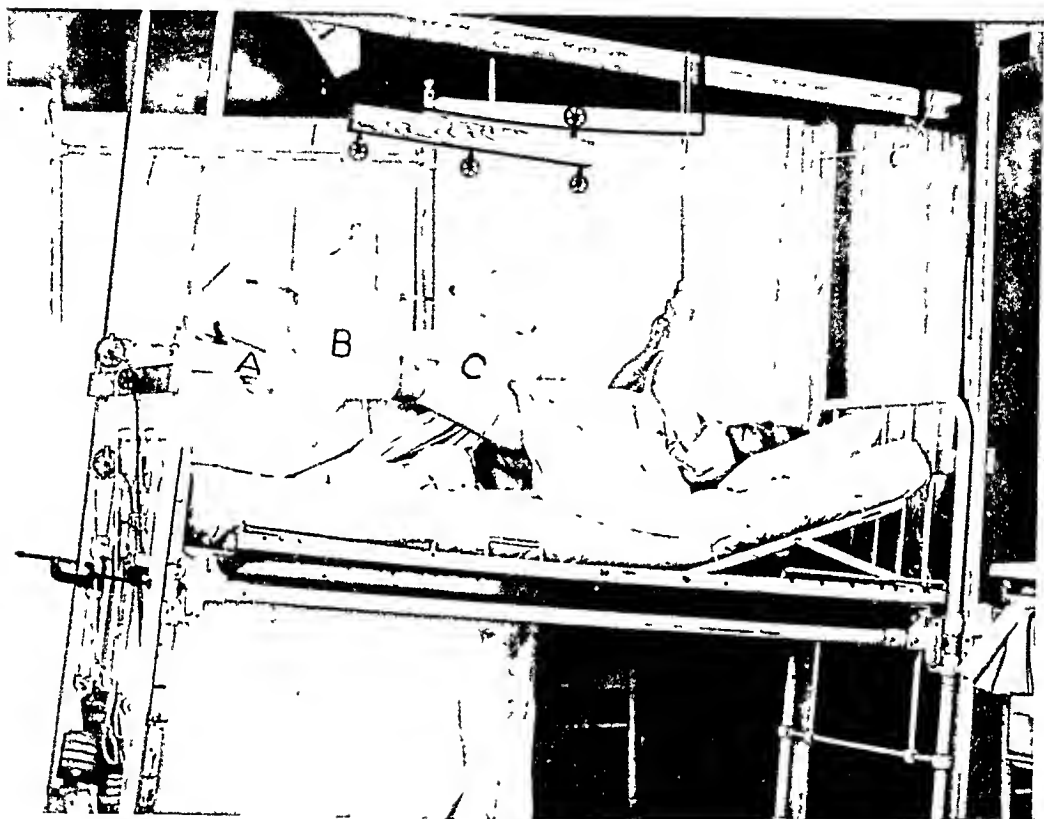


FIG 3—H 5117. A R, age 48 Showing freedom with which patient can move about in bed

bed. To it eight to ten pounds of weight is attached. This sling serves at least two purposes. In fractures of the lower third it tends to draw the upper end of the distal fragment forward into alignment with the upper fragment. In all cases it acts as a coaptation splint which supports the thigh and prevents sagging of the fragments posteriorly due to gravity. Foot drop is prevented by traction applied to the sole of the foot, the traction cord with its attached weight running over the middle pulley of the "traveller." In fractures of the lower third this may be omitted for the first two or three days to obtain a better relaxation of the gastrocnemius. Counter-traction is obtained by raising the foot of the bed about eight inches from the floor.

Such a combination of weight and pulley traction permits of a considerable amount of movement on the part of the patient without in any way disturbing the force or direction of the traction. (See Fig. 3.) If the patient raises himself in bed, the weights immediately adjust themselves, and if he shifts

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toward the head or foot of the bed, the traveller moves along its bar and keeps the pulleys in the same relation to the slings. The nursing care of such a patient is therefore much easier to carry out than is the case when other methods, such as immobilization in a spica cast, are employed.



FIG. 4.—A. R., age 48, 15th day. Antero-posterior and lateral views. Associated with hæmarthrosis of knee. Balanced traction maintained for 31 days. At present (6 months after accident) patient walks with only a very slight limp and has 75° of motion in the joint.

Since developing the above method, it has been our practice to apply it to cases of fracture of the shaft of the femur *immediately* on admission. It can be carried out without an anæsthetic and quite without pain. An X-ray is taken with a portable outfit as soon as possible after admission, but we have not waited for X-rays feeling that the early application of traction before massive infiltration of the muscles shall have taken place is an important

element in the success of the method. Usually no attempt is made at first to manipulate the fracture, but the reduction is left to the system of traction entirely.

Report of Cases.—Eleven simple fractures of the shaft of the femur have been treated by this method. One patient was a boy of eleven, one was



FIG 5.—F. L. age 24, 15th day. Antero-posterior and lateral views.

seventeen; the remainder were adults, the oldest being sixty-four years of age. Four were females, seven were males. The site of the fracture was in the middle third in five cases, in the upper third in four cases, and in the lower third in two cases. In five the line of fracture was transverse, in three it was oblique, while in three comminution of the fragments was present. In one of the latter the line of fracture entered the knee-joint and was associated with a hæmarthrosis.

In 8 of the 11 fractures the first X-rays taken after traction was applied showed the position of the fragments to be entirely satisfactory and in two of the eight the reduction was almost anatomically perfect. In the remaining

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three instances further adjustment of the traction was necessary, but in all of the eleven cases satisfactory reduction of the fragments was ultimately obtained. The average amount of traction used in male adults was twenty-four pounds on the traction straps and twelve pounds on the leg sling; in the females twenty pounds and ten pounds were sufficient. Ten and one-half pounds was the average pull on the thigh sling. However, in our later cases, we have used somewhat less weight with equally satisfactory results. If the first X-rays show the fracture to be in good position about one-third of the weight may be removed after two or three days.

The length of time that the traction was maintained varied from 17 to 57 days—the average being 33 days. All but one case showed quite firm union at the end of this time. This case—complicated by the presence of multiple fractures elsewhere—had delayed union, but firm union was ultimately obtained. After the removal of the traction further immobilization was employed in all but one case to prevent subsequent bowing. Single spica casts were applied in three patients, while five were discharged in ambulatory splints.

Hospitalization Time.—The hospitalization period of these cases varied from 31 to 103 days, the average being 55 days. If we exclude the case with multiple fractures the average was only 50 days. This is 8 days less than a recently reported series of 40 cases treated by other methods.² In Eliason's series³ the average stay reported was 63 days, and in Bosch's series⁴ was 93 days.

Shortening.—In but one of these cases was there any measurable shortening of the involved leg at the time of discharge. This patient was a man who had two inches of shortening of the involved leg the result of an old arthritis of the hip and had customarily walked with the sole of his shoe elevated about two inches. He was discharged with $1\frac{1}{4}$ inches shortening, has had the lift removed from his shoe and at present, six months after his accident, is working at his former occupation.

Martin,⁵ in reviewing 112 fractures of the femoral shaft in adults treated in Buck's extension, gives the average shortening as 1 inch. Bosch,⁴ in 223

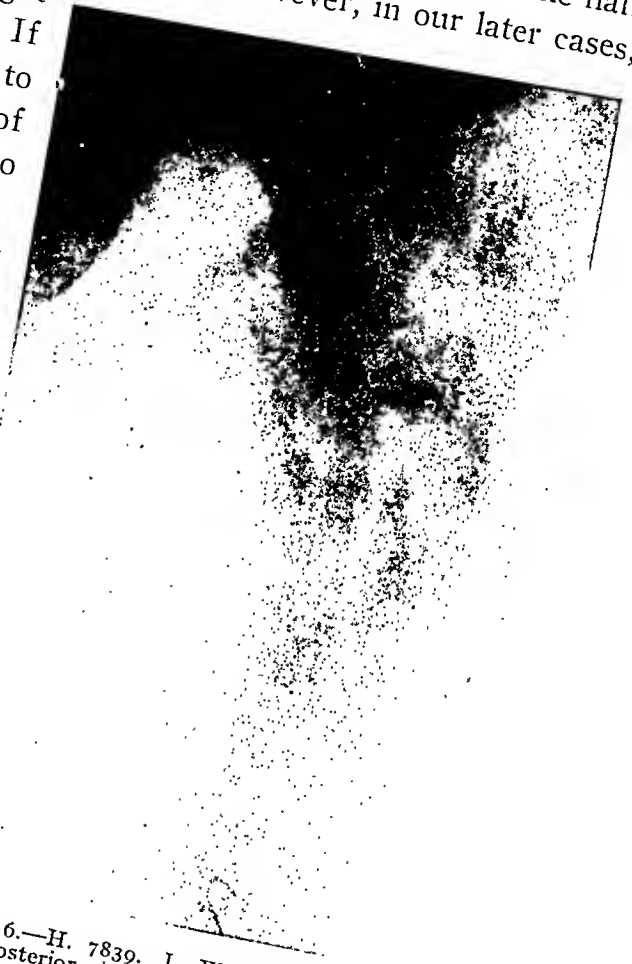


FIG. 6.—H. 7839. L. W., age 63, 40th day. Antero-posterior view. A very obese patient who would not tolerate a plaster spica and in whom an open operation was impossible due to cardiovascular-renal conditions. Balanced traction maintained for 32 days.

cases of all ages and treated by various methods, saw an average shortening of 1.7 cm., and Estes,⁶ in analyzing 457 such cases, reports an average shortening of 1.5 cm. In a series of 40 fractures of this kind treated in this hospital by methods other than balanced traction, there was an average shortening of about 2 cm.

Angulation.—Three cases had slight angulation at the site of fracture



FIG 7—M. S., age 20, 57th day. Lateral and antero-posterior views. Multiple fractures elsewhere. Balanced traction maintained for 57 days. Union present but not firm at that time. Spica cast therefore applied for about 3 weeks. Discharged with firm union.

which was demonstrable only in the X-ray plates. In two cases the angulation was internal; in one posterior.

Joint Motion.—Ten of the eleven patients had at least 45° of joint motion at the knee when dismissed from the hospital.

Callus Formation.—All cases had callus which was both visible in the X-ray and palpable at the time of discharge.

Atrophy.—It has been our impression in comparing cases treated by this method with those in which prolonged immobilization in plaster was employed,

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that there is little or no atrophy of the involved leg when traction is applied. This impression has been confirmed by two cases in which comparative measurements of the two legs at the time of discharge failed to show any differences in the circumferences of the two.

Late Results.—Two cases are too recent to permit a report of the ultimate result. Of the remaining nine patients seen or heard from more than six months after discharge, seven have perfectly functioning limbs and are able to work at their previous occupations. One patient, in whom the fracture involved the knee-joint, walks with a slight limp, has 75° of motion at the knee and is rapidly improving under physiotherapy. Another, in whom the fractured femur was associated with multiple fractures elsewhere at the union was somewhat delayed, left the city on being discharged and began weight-bearing too soon. A note from her present physician reports a considerable amount of bowing at the site of the fracture.

Summary.—1. A method for the treatment of fractures of the shaft of the femur in adults by means of balanced traction is presented.

2. The method seems to us to present the following advantages:
 - (a) Its application can be carried out almost painlessly without anaesthesia.
 - (b) It possesses all the advantages of skeletal traction with none of the disadvantages of the latter method and can be used in certain cases, such as those associated with marked swelling of the knee-joint in which the use of skeletal traction is attended with considerable risk.
 - (c) The traction alone, if properly applied, suffices to accomplish the reduction and fixation of the fracture in the large majority of the cases; eight of the eleven in this series.
 - (d) It permits the patient to move about in bed to a considerable extent without pain and without disturbing the force or the direction of the traction. The nursing care of such patients is therefore made much easier and their comfort increased.
 - (e) It can be successfully carried out in cases in which other methods fail or are not tolerated and in which open operation is contra-indicated, due to the physical condition of the patient, as in two instances in this series.
 - (f) There is less stiffness of the knee and less muscular atrophy following the use of this method than when casts alone are used.

3. Eleven simple fractures treated by this method are reported with an average hospitalization time of 57 days and with no measurable shortening on discharge in ten. In the other case the limb is probably no shorter than before the accident (v. s.). Ten had at least 45° of motion at the knee when discharged. Seven are already returned to their former occupations with excellent functional results.

The accompanying X-rays taken at various stages indicate some of the types of fracture encountered and the results obtained. We have lately applied this method in the treatment of intertrochanteric fractures and hope that its principle may prove applicable to fractures of other long bones.

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An Analysis of the Immediate Results in Forty Cases of Fracture of the Shaft of the Femur.—This report deals with the forty fractures of the shaft of the femur in patients over twelve years of age treated on the surgical service of the Cincinnati General Hospital between January 1, 1922 and July 1, 1923. Only fractures below the trochanters are included.

Age.—The youngest patient in this series was 13 years of age; the oldest, 79 years of age. Dividing the cases into decades we find 8 cases or 20 per cent. between 12 and 20 years; 4 cases or 10 per cent. between 20 and 30 years; 6 cases or 15 per cent. between 30 and 40 years; 9 cases or 22 per cent. between 40 and 50 years; 6 cases or 15 per cent. between 50 and 60 years; while 7 cases or 18 per cent. were over 60 years.

Sex.—Twenty-six or 65 per cent. of these fractures were in males while 14 or 35 per cent. occurred in females.

Level of Fracture.—The upper $\frac{1}{3}$ was involved in 5, or 12.5 per cent. of the cases; the middle $\frac{1}{3}$ in 20, or 50 per cent. and the lower $\frac{1}{3}$ in 15, or 37.5 per cent. The two sides were involved an equal number of times. In one case both femurs were fractured in the middle $\frac{1}{3}$; the right obliquely; while the line of fracture in the left femur was described as transverse.

Type of Fracture.—The type of fracture was given as oblique in 13 cases (32 per cent.); as transverse in 13 cases (32 per cent.); and as comminuted in 14 cases (36 per cent.). When we analyze the types of fractures with reference to their location we find the oblique type equally distributed, the comminuted more frequent in the lower and middle thirds, while 10 of the 13 transverse fractures were located in the middle third. Thirty-three were described as simple fractures, while 7 were compound. One of the simple fractures was a pathological fracture due to metastases from a carcinoma of the breast in a woman fifty-three years of age; three of the compound fractures were gunshot fractures from revolver bullets.

Mortality.—There were 6 deaths; five from pneumonia in patients over

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60 years of age; and one from bronchopneumonia complicating a lung abscess which ante-dated the fracture.

Treatment.—The emergency treatment in 30 of these cases consisted in immobilization in a Thomas splint. In 3 cases a spica plaster bandage was applied at once; in 3 the leg was placed in a padded basket splint; in 2 a plaster bandage had been applied at another hospital; in one Buck's extension was applied; and in another, a pathological fracture, sand bags were placed about the leg.

An attempt at reduction was made immediately on admission in 19 cases. In 9 an attempt at reduction was made within the first 24 hours; while in 6, more than 24 hours had elapsed between admission and any attempt at reduction. In the two cases admitted in plaster and in four other cases no primary attempt at reduction was made because of the condition and age of the patients.

Of the above 34 primary attempts at reduction, 11 including 3 primary open reductions, or 32 per cent. were successful; but if we exclude the 3 primary open reductions in compound fractures we find that only 8, or 23 per cent. of the 31 primary attempts at closed reduction were successful. This is about the same proportion of satisfactory primary reductions reported by Eliason¹ in his series. In 4 of these 8 cases spica plaster bandages, including the foot on the injured side, the pelvis and the thigh of the uninjured side were applied. In the other 4, immobilization in Thomas splints proved satisfactory.

Subsequently 58 attempts at closed reduction were made in the remaining 23 unsuccessful cases. These were as follows: thirty-six to immobilize in spica plaster; 4 in leg plaster; 13 in Thomas splints; and 5 in some form of traction apparatus. However, in only 14 of the 23 cases were reductions obtained which were considered satisfactory. The remaining 9 cases eventually came to open reduction; in 5 of which Lane plates were applied; in 3, Parham bands; and in 1 a medullary bone graft.

Of the 6 compound fractures treated, 3 had open reductions with débridement and complete closure within 8 hours of injury; two were immobilized in plaster with windows cut at the site of the wound; and 1 was put up in a simple Buck's extension.

Complications of Open Reductions.—In 12 open reductions infection occurred twice; once in the 9 simple fractures so treated; and once in a compound fracture which was grossly soiled on admission and was operated upon about 8 hours after injury. The plate became bent in one case and entailed a second operation. In another case a beef-bone peg which had been inserted into the medulla slipped and allowed the fragments to over-ride. Two cases developed pneumonia complicated in one by lung abscess; but both ultimately recovered. One patient developed tetanus 74 days after

sustaining a compound gunshot fracture of the right femur from which he recovered.

Results. Days in the Hospital.—The hospitalization period for the simple fractures treated by closed reduction varied from 43 to 151 days, the average being 58 days; while, for the 7 compound fractures the time varied from 84 to 403 days, the average stay being 149 days.

Pott (1768) and Malgaigne (1839), called attention to the importance of an early attempt to overcome the shortening and muscle spasm, and of placing the leg at rest before massive infiltration of the muscles should have taken place. And many others since (Bardenheuer,³ Henschen,² Boorstein and Landsman,⁴ Conference of American Orthopædists on fractures at Boston 1922,⁵ and others have pointed out that in almost all fractures an early immobilization of the fragments with at least an attempt at reduction influences, in no small degree, the subsequent course of the case and often the ultimate result.

This is nowhere better demonstrated than in fractures of the shaft of the femur in adults. If an attempt at immobilization is not made within a few hours after injury it is often impossible even under ether anæsthesia to overcome the shortening by manual traction sufficiently to permit a satisfactory apposition of the fragments. The heavy thigh muscles, shortened somewhat because of the break, soon become infiltrated with blood; and attempts to overcome this shortening become increasingly more difficult with the lapse of time.

With this in mind it is of interest to note the apparent effect of an early attempt at reduction on the hospitalization time in the simple fractures uncomplicated by other conditions. In 8 such cases in which an immediate attempt at reduction and immobilization was made the average time in the hospital was 69 days, the extremes being 35 and 116 days; whereas, in 6 others in which no such attempt was made until after 24 hours had elapsed the average hospitalization time was 103 days, the extremes being 71 and 121 days.

Union.—Of the 34 cases in which treatment was carried out, 31 had firm union at the time of discharge and were walking with crutches at that time. Of the remaining three, one was discharged in a plaster spica, one left the hospital against advice before it was time to remove the case, and the third was discharged in a "side-splint."

Shortening.—The average measured shortening on discharge (anterior-superior spine to tip of internal malleolus) in this series was slightly less than 2 cm. (1.95). In simple fractures it was 1.8 cm.; in compound fractures, 2.3 cm. Nine cases (three compound; six simple) had no shortening; while, the remainder had varying amounts, the maximum for simple fractures being 4 cm.; for compound fractures, 6 cm.

This also varied somewhat with the type of fracture, the comminuted fractures showing an average shortening of 1.3 cm.; the oblique, 2.2 cm.; and the transverse, 2.4 cm.

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The fractures of the upper third showed the greatest average shortening (2.8 cm.), whereas, in the middle and lower thirds the average shortening was 1.75 cm. and 1.25 cm. respectively. These figures are influenced somewhat, however, by the fact that all the cases treated by open reduction which therefore allowed of more accurate replacement of the fragments were fractures of the middle and lower thirds.

Here again the shortening present is evident. For in those uncomplicated cases to which extension was applied immediately on admission or in which an immediate attempt at reduction under anaesthesia with application of a plaster spica was made, there was an average shortening of 1.3 cm. On the other hand, in those cases in which no such attempts were made, the leg simply being placed in a basket splint or surrounded by sand bags, and an attempt at reduction made later, the average shortening was 3.5 cm.

Joint Motion.—In 9 cases there was no motion in the knee-joint on discharge. Thirteen cases had 30 degrees of flexion; 5 had 60 degrees of flexion; while in 2 cases, both boys of 13 years, there was full motion in the knee. The degree of joint motion was not recorded in 5 cases. In general the younger the individual the less is the liability to stiffness from simple immobilization. Also, in fractures of similar nature, those cases treated by extension, in the Thomas splint, for example, tend to have less stiffness of the knee than those treated in plaster.

Four cases had draining sinuses at the time of discharge; two of these had had open reductions and two were compound fractures in which no attempt at primary closure of the wound had been made.

SUMMARY

1. Forty fractures of the shaft of the femur (33 simple and 7 compound), are reported in patients from 13 to 79 years of age, with a 15 per cent. mortality.
2. Treatment in the majority consisted in primary immobilization in a Thomas splint with closed reduction and application of a plaster spica later.
3. There were 12 open reductions with 2 infections (16.6 per cent.).
4. The average hospitalization time was 58 days for the simple and 149 days for the compound fractures.
5. The average shortening was 1.8 cm. in the simple cases and 2.3 cm. in the compound.
6. Three cases were discharged before union was complete; the remainder had firm union at the time of discharge.
7. Nine cases were discharged with no active motion in the knee; 13 with 30 degrees of mobility; 5 with 60 degrees; and 2 with full motion.
8. An early attempt at reduction and immobilization influences markedly the hospitalization time and the end results in fractures of this type.

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ASTRAGALECTOMY (THE WHITMAN OPERATION) IN
PARALYTIC DEFORMITIES OF THE FOOT

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IN 1916, one of the writers¹¹ read before the Orthopædic Section of the American Medical Association a paper on "Astragalectomy in Infantile

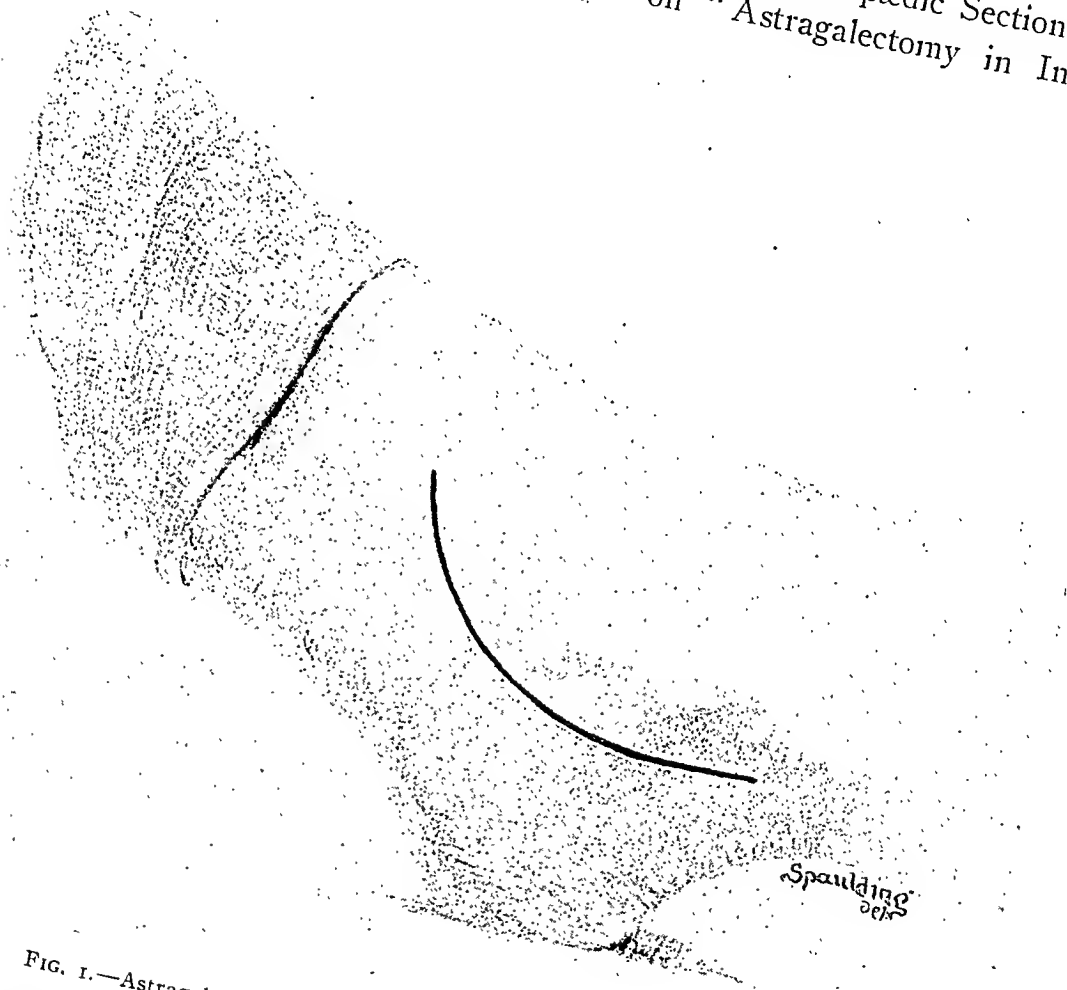


FIG. 1.—Astragalectomy—the Whitman operation. Line of incision.

Paralysis," which included a review of the literature of the subject up to that time, and covered a series of one hundred and thirty-five cases. In 1920, J. W. Sever¹⁸ published an article in the *Journal of the American Medical Association*, reporting two hundred and seventeen cases of astragalectomy done at the Boston Children's Hospital, by eight surgeons. The results recorded by Sever are so diametrically opposite to those which were reported in the above paper that, in justice to the classical operation described by

Whitman,²² we believe it necessary to make a further report of a series of two hundred and forty-seven of our own cases.

The Importance of Muscle Balance in the Foot.—The normal foot is balanced by muscles which work in perfect coördination, assisted by ligaments which check the extremes of motion. When paralysis involves the foot, the resultant damage varies from a slight, almost unrecognizable lack of muscle

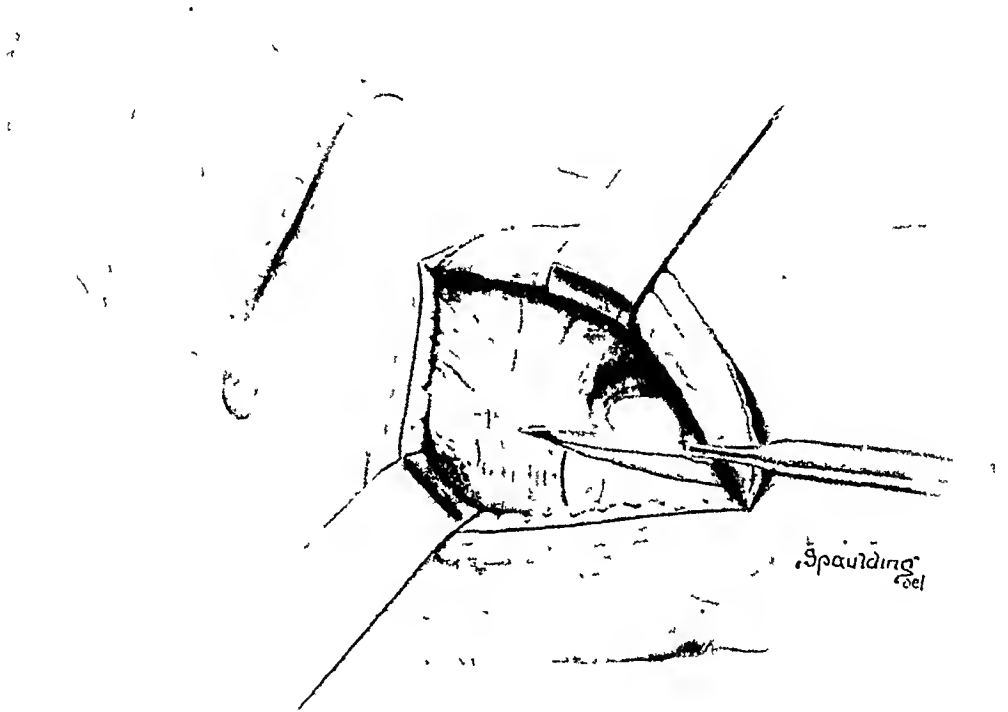


FIG 2 —Tendon of peroneus longus exposed, tendon of peroneus brevis being exposed.

balance or weakness of a single group, to a complete paralysis of all the muscles. Lack of muscle balance causes two serious conditions, *instability* and *deformity*. The instability, which is greatly increased by the presence of paralysis elsewhere, may impair function out of all proportion to the extent of the paralysis. Deformity develops eventually in practically all cases from unopposed muscle pull. The recognition of this fact and the prevention of deformity are most important, since no reconstructive surgery can be done until all deformity has been corrected.

The Relation of Shortening (and Atrophy) to the Extent of Paralysis.—Instability, particularly with the additional handicap of deformity, is the major factor in determining the amount of shortening. The authors observed long ago that many severe and extensive paralyzes developed only one or two

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inches of shortening, whereas many cases with a single paralyzed group of muscles had as much as two to four inches. Analysis showed that patients using the leg well in walking developed less shortening than those using the leg poorly. Further, it was apparent that insecurity or instability of the foot caused the patients in the latter group to hop quickly over the weak leg, using it as little as possible. This explains perfectly why calcaneovalgus is asso-

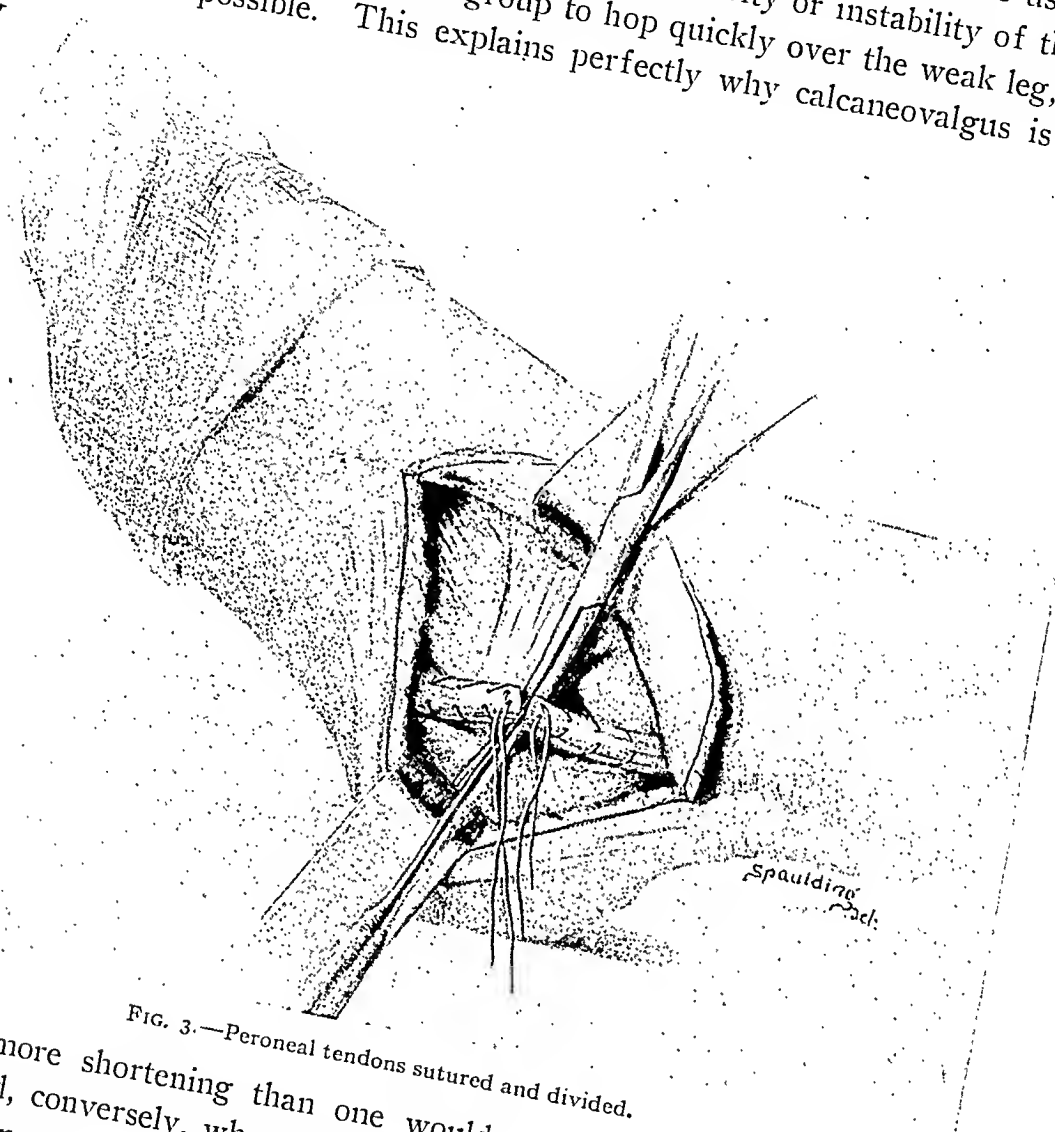


FIG. 3.—Peroneal tendons sutured and divided.

ciated with more shortening than one would expect from a single group paralysis; and, conversely, why almost flail legs vigorously used, show less shortening than one would expect. It becomes unnecessary to fall back on the term "trophic" to explain shortening.

Early "stabilizing" operations are amply justified to avoid shortening. *The Object of Astragalectomy.*—The object of astragalectomy is to make a new ankle-joint (an arthroplasty) which, with such muscle as is present, will be stable and well balanced. When properly done, an astragalectomy shifts the weight-bearing line to the front by the forward displacement of the tibia and the fibula, thereby obtaining a so-called "rocking-horse foot," with the weight-bearing near the middle—the point of advantage—rather than on the "backstep of the rocking horse" as is clinically seen in a case of calcaneovalgus. The fulcrum is increased by the lengthening of the posterior arm or the distance between the weight-bearing line of the tibia and fibula

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 and the back of the heel. This change in weight-bearing is particularly efficient when the peronei are transplanted into the Achilles tendon, in which position they not only tend to prevent recurrence of calcaneus but in most cases may even assist in plantar flexion.
Astragalectomy not for Ankylosis but for Mobility (Arthroplasty).—
 There seems to be a widespread impression that the operation results in anky-

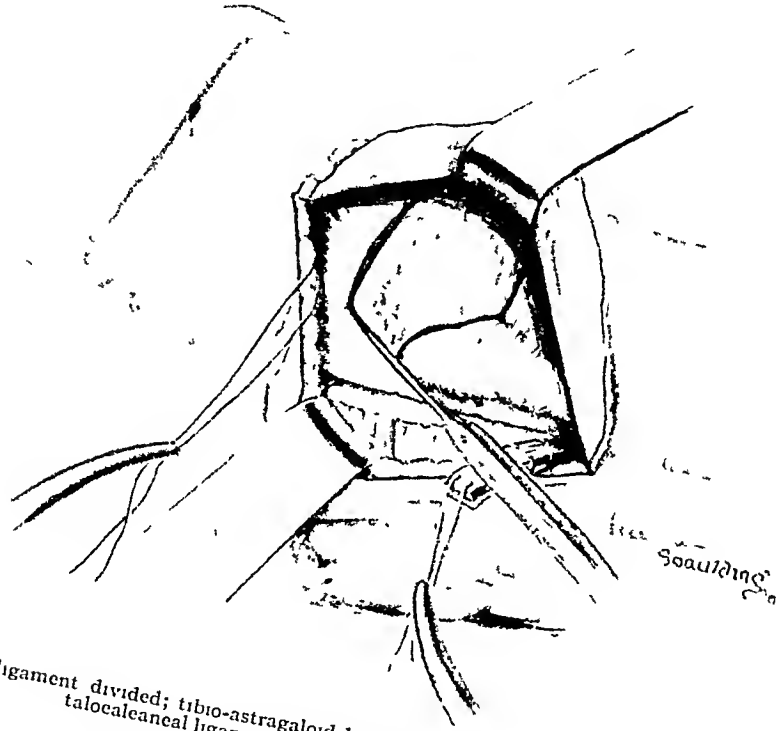


FIG 4.—External lateral ligament divided; tibio-astragaloid ligament divided, interosseus and external talocalcaneal ligaments being divided

losis, but ankylosis is neither sought nor expected, and if it does occur should be regarded as an unfortunate result. Astragalectomy has a distinct advantage over arthrodesis, in that it not only *stabilizes* but also *preserves motion*.
Indications and Contra-indications.—Astragalectomy should never be done in the presence of any structural deformity. This, if present, should be corrected by manipulative methods and the foot held in overcorrection for several months (walking being allowed) before astragalectomy. This necessary principle may have been overlooked in some of the many failures reported in the series from the Boston Children's Hospital.
 Astragalectomy is indicated in *calcaneus deformities*, especially in valgus, for which it was originally devised by Whitman.²² In calcaneovarus, it is important first to eliminate all varus deformity by repeated stretchings and by

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retention of the foot in overcorrection. After months of overcorrection, astragalectomy may be done with safety.

In *dangle-foot* astragalectomy results in stability, the weight being transferred to the centre of the foot, the arch elongated, and the os calcis made more horizontal. In cases in which only the plantar flexors remain, great care must be taken to prevent the deformity of equinus.

In *equinus* deformities (with no power in the anterior group) astragalectomy is useful in increasing stability, but great care must be taken to prevent a recurrent deformity. In severe *equinovarus*, after repeated stretching, the removal of the astragalus is frequently the coup-de-gras needed to complete and maintain a serviceable foot without deformity.

Astragalectomy is very valuable in severe *claw-foot*. The great relaxation of the soft tissues occasioned by the removal of the astragalus gives the opportunity to save many feet that otherwise would be amputated. Slight or moderate varus and *equinovarus* may be treated by other methods.

Formerly we have included a few cases of *equinovalgus* in our list of astragalectomies, but the recent addition of the "loop" operation, also devised by Whitman, is replacing astragalectomy or astragalo-scaphoid arthro-

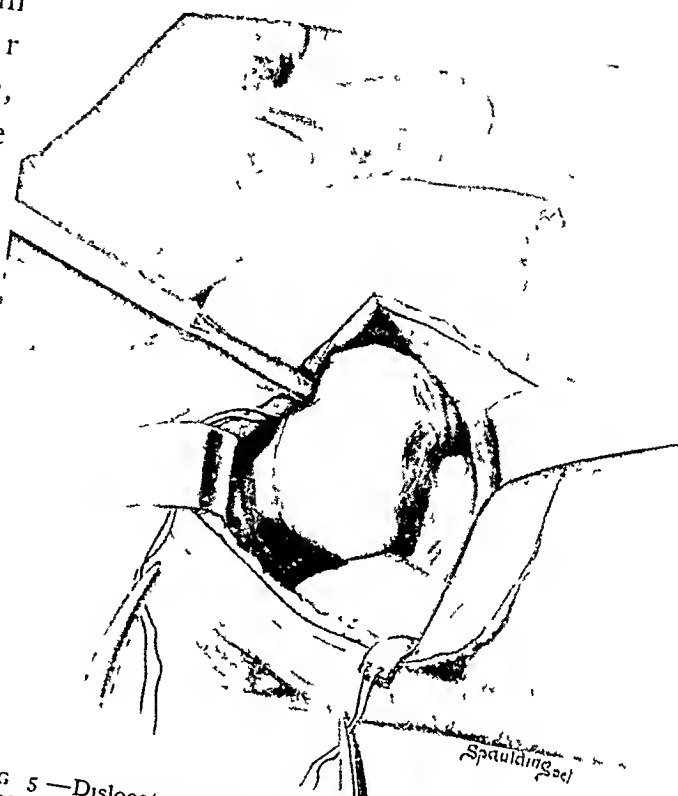


FIG 5—Dislocation of astragalus by strong inversion of foot. Note heavy dissector under neck by which astragalus is pried loose head first

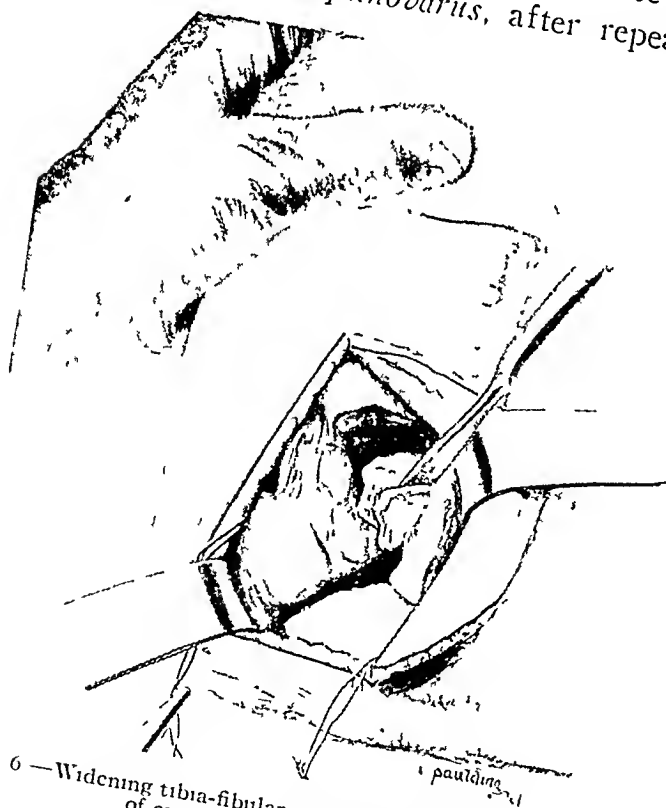


FIG. 6—Widening tibia-fibular articulation by removal of thin slice of cartilage from internal malleolus

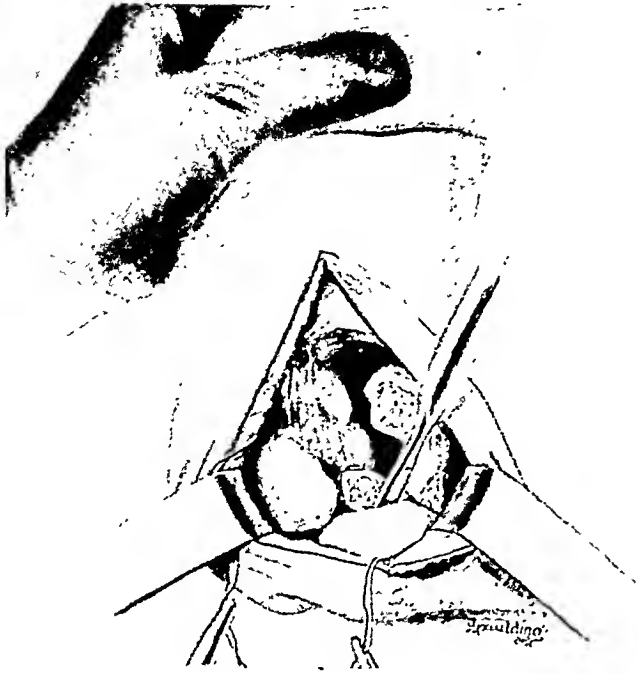


FIG. 7.—Widening the tibia-fibula articulation by removal of thin slice of cartilage from one or both; the internal lateral ligament has been dissected up to sharpen the malleolus.

Operative Technic.—Asepsis should be guarded carefully and all manipulations should be gentle. A tourniquet is applied after the Esmarch bandage.

A curved or L-shaped incision is made around the external malleolus extending forward over the head of the astragalus. (Fig. 1.) The upper flap is then dissected upward, exposing the tendons of the peroneus longus and brevis, which are dissected free and severed at the fibular tip. The ends are sutured with No. 2 catgut and retracted. (Figs. 2 and 3.) An incision is then made through the external ligaments around the astragalus, special care being taken about the head of the astragalus. (Fig.

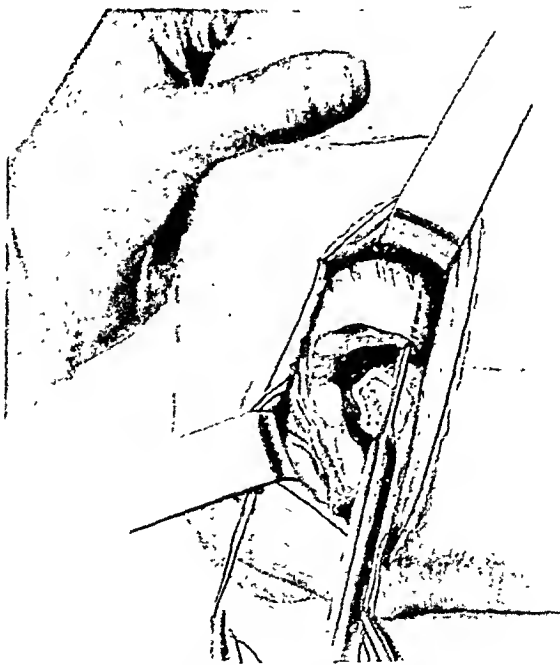


FIG. 8.—The new articulation for internal malleolus. Note removal of inner one-fourth to one-sixth from inner side of scaphoid, thus forming pocket for sharpened internal malleolus.

4.) The foot is then strongly inverted. By means of a blunt dissector placed under the neck of the astragalus the bone is pried out of position, head first,

desis in paralysis of the anterior tibial.

Age.—Any operative interference should be withheld until two years have elapsed since the original paralysis. It is neither necessary nor advisable to do an astragalectomy before this period. Also, we do not advise an astragalectomy before the age of six years, and it is better to wait until the child is eight years old. The ages between eight and sixteen years have been found the best, for in this period *motion is easily preserved*.

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and removed—a veritable coup-de-main when well done, taking less than thirty seconds. (Fig. 5.) The ease with which the foot may be displaced backward will be appreciated at once, but in order to ensure a good, stable joint a certain amount of careful modelling must be done.

The internal lateral ligament is dissected upward from the internal malleolus, more in cases of equinovarus than in other cases. If necessary, a strip of cartilage is removed from both tips to allow spanning of the scaphoid and cuboid. (Figs. 6 and 7.) A thin slice of bone is then excised from the sides of the scaphoid and cuboid to form pockets for the malleoli. (Figs. 8 and 9.) The foot is displaced backward and held carefully in this position to ensure the proper relations in the new joint. This backward displacement of the foot which checks lateral movements by actual bony contact between the scaphoid and the tibia, is the essential feature of the Whitman operation. A moderate

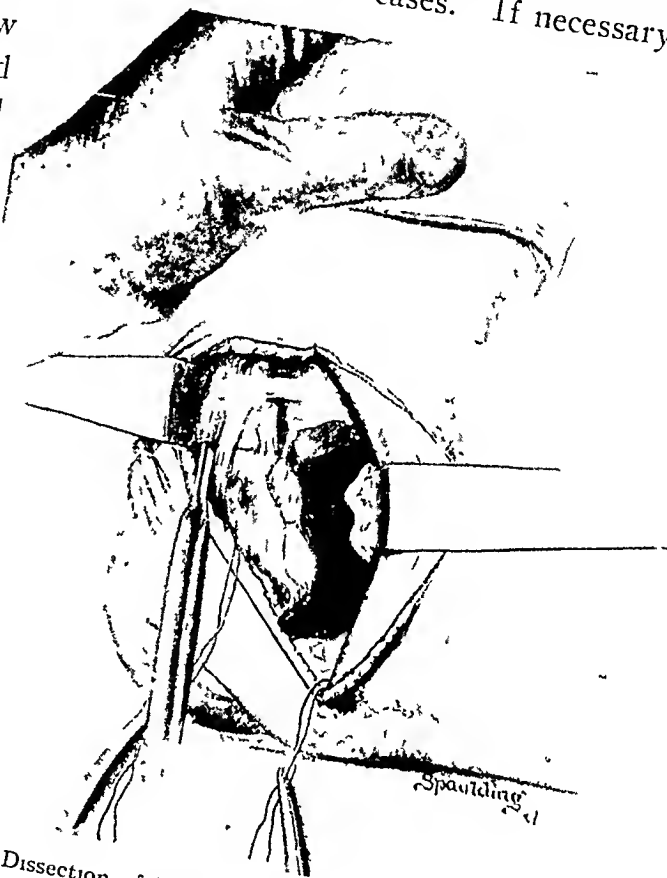


FIG 9 —Dissection of ligaments up to make pocket for fibula by the cuboid.

equinovalgus ensures stability while holding. (Figs. 10, 11 and 12.) The peronei are disposed of by (a) suture to the Achilles tendon, by (b) tendon fixation to the fibula, or by (c) resuture to the tendons of the peronei, as indicated in the given case. (Figs. 13, 14, and 15.) The skin is closed with catgut, and plaster is applied from the toes to the mid-thigh with the knee flexed and the foot in slight equinovalgus. (Fig. 16.) The leg is kept elevated for a period of ten days, after which crutches may be used. The first change of plaster case takes place in three or four weeks, at which time the equinus is corrected to a right angle in cases where the quadriceps is present, or is left in 5° to 8° equinus in cases in which the quadriceps is paralyzed. The mechanical value of this must be apparent. Valgus should persist to a slight degree throughout the treatment. A leather shoe is then put over the plaster and the child is allowed to walk, changing the plaster as necessary during the next five or six months. After its removal, a shoe with a lift on the outer side of the sole is used to maintain valgus. A one-half or three-quarters inch cork lift worn

under the heel throughout life will compensate for the shortening of the leg and improve the gait. Circulation improves rapidly with the return of active use, loss of growth ceases, and the paralyzed leg begins to grow at a rate equal to that of the well side.

After the removal of the plaster, it is sometimes advisable for older patients to wear a limited motion ankle brace, either in the form of an ortho-

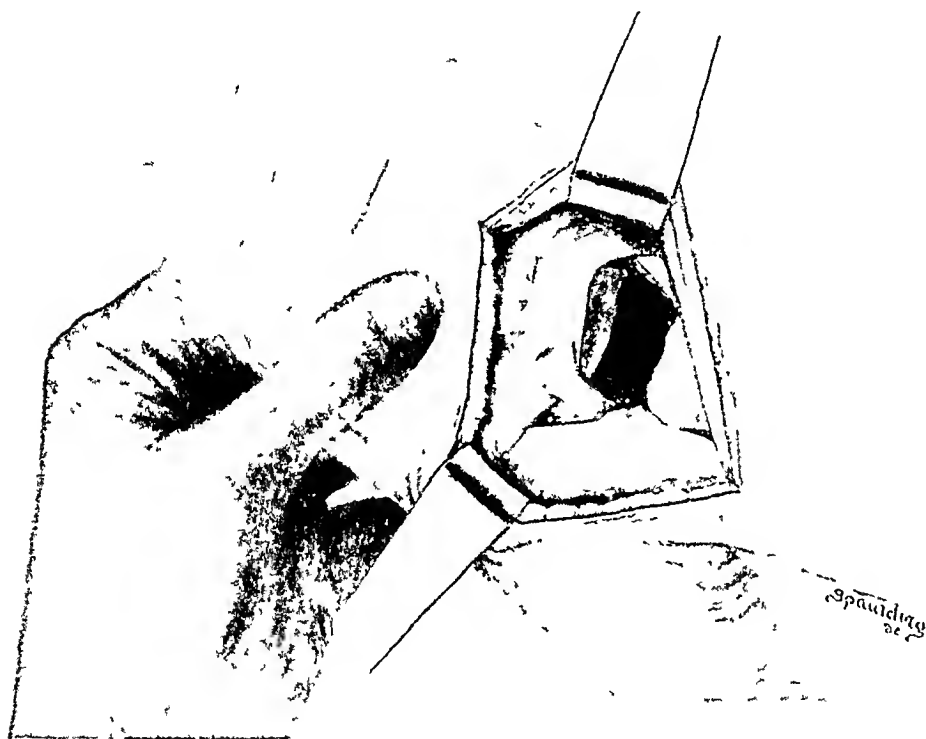


FIG 10 —Fibula and tibia being inserted into pocket

pædic shoe or an inner or outer upright to protect the foot from strain during the early months of weight-bearing.

Steps in Technic.—1. Correct all existing deformities before open operation.

2. Astragalectomy may be done with or without tendon transplantation, tendon fixation of the peroneals or transplantation through the Achilles and resuture, with strong displacement of the foot backward.

3. Proper after-care. This should be followed by the operator and not by untrained assistants.

4. Prevention of Complications. Recurrent deformity is due to improper post-operative care.

Lack of posterior displacement is due to careless or improper operative technic, such as failure to remove head of astragalus. (See reproductions of X-rays accompanying Sever's ¹⁸ paper.)

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We recently examined two hundred forty-seven cases operated from two to ten years ago. The majority of the cases were calcaneovalgus deformities, but varus, equinovarus, equinovalgus, and dangle-foot types were also represented. The age of the patients varied from three to twenty years, with an average age of eight to ten years.

In all cases of calcaneovalgus the peroneals were transplanted into the Achilles, with resulting increased function. In twelve cases, the peronei were

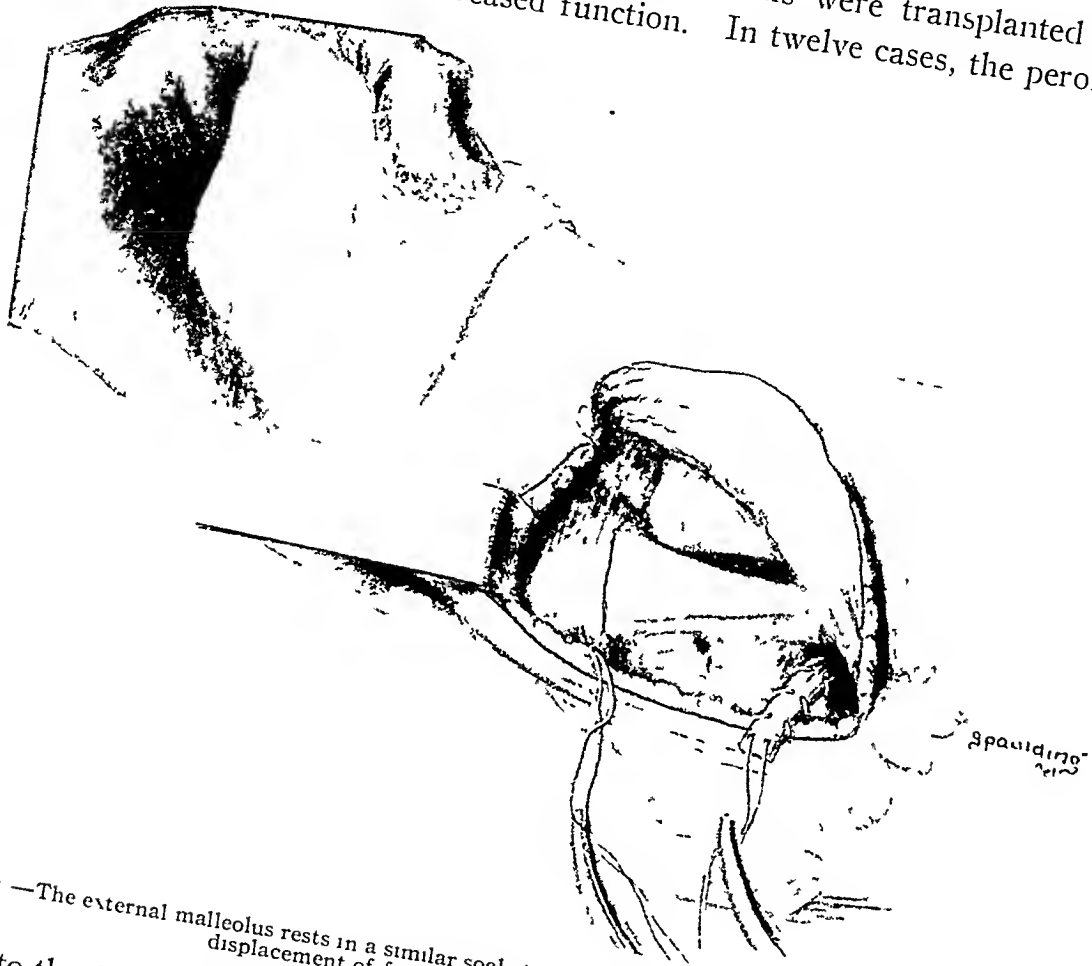


FIG 11 —The external malleolus rests in a similar socket over calcaneo-cuboid joint. Note —1, backward displacement of foot. 2, fibula carried well forward.

The foot was kept in plaster for fixed to the fibula with satisfactory results. The foot was kept in plaster for an average of five months.

Out of the two hundred forty-seven cases, post-operative deformity developed in twelve, and of these varus developed in seven. In the later group, one patient refused after-treatment following astragalectomy; one insisted that the family physician change the cast; and the remaining five developed deformities from improper after-care in our hands. These, however, were corrected in every case before the patient was finally discharged.

One case of equinovarus deformity recurred. The patient did not return to the clinic for after-care.

There was one case of sloughing of the toe from swelling which developed because the patient was taken home and no attempt was made to keep the leg elevated; the end result was good.

The satisfactory results we have obtained lead us to recommend the Whitman operation in most cases in which stability with motion is desired.

ILLUSTRATIVE CASE ABSTRACTS

CASE I.—F. H. Age thirteen. Calcaneovalgus deformity. *Complaint:* Limp of the left leg. *Duration:* Nine years. *Cause:* Infantile paralysis. At four years of age, this patient had a "fever" resulting in paralysis of the left leg.

Physical Examination.—The left foot was held in calcaneovalgus deformity. There

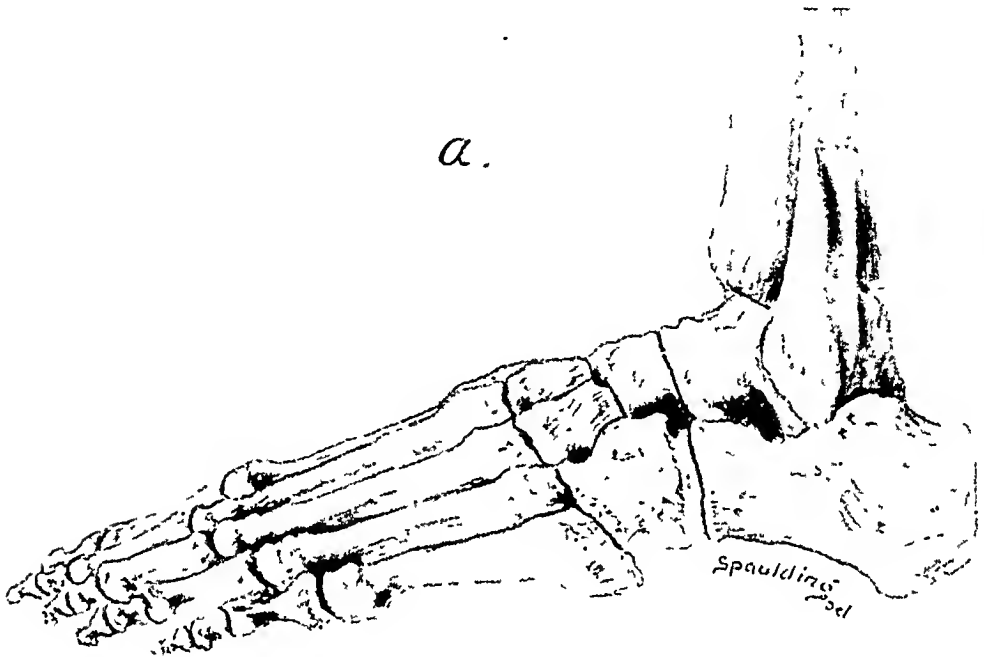


FIG. 12a.—Normal relation of tarsal bones.

was power in the peronei and the outer dorsal flexors, but there was no power in the posterior or inner groups. There was one and three-fourths inches shortening, mostly in the lower leg. The quadriceps was present, although weak.

Treatment: October 14, 1919.—An astragalectomy was performed according to the usual technic. Plaster was applied with the foot in about 5° plantar flexion. The case above the knee was removed at the end of three weeks. New cases were applied on November 29, 1919 and February 24, 1920. About the fifth week, felt was put under the heel and the patient was allowed to walk on the plaster ease.

March 20, 1920.—The cast was removed and a flannel bandage applied.

March 31, 1920.—The foot was in excellent position and the patient was advised to wear a three-eighths inch lift under the heel inside the shoe.

October 18, 1920.—The position of the foot was excellent, and there was good motion. A one and three-fourths inch lift was worn under the heel, a one and one-half inch lift under the sole, and a one and one-fourth inch lift at the toe. Of this amount, one-half inch was put inside the shoe at the heel and one-fourth inch at the sole.

April 16, 1923.—The foot was in excellent condition. *Result:* Good function.

CASE II.—J. Hart. Age ten. Calcaneovalgus deformity. *Complaint:* Lameness. *Duration:* Since seven months old. *Cause:* Infantile paralysis. The onset was sudden.

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When seven months old the patient had infantile paralysis, and was in bed three weeks. At first both legs were affected, but later only the feet were in bad condition.

Physical Examination.—Calcaneovalgus of the left foot. Outer hamstrings absent; left thigh and gluteal muscles about one-half normal. No power in the calf muscles or in the extensors of the toes.

Treatment: May 27, 1919.—An astragalectomy was performed according to the

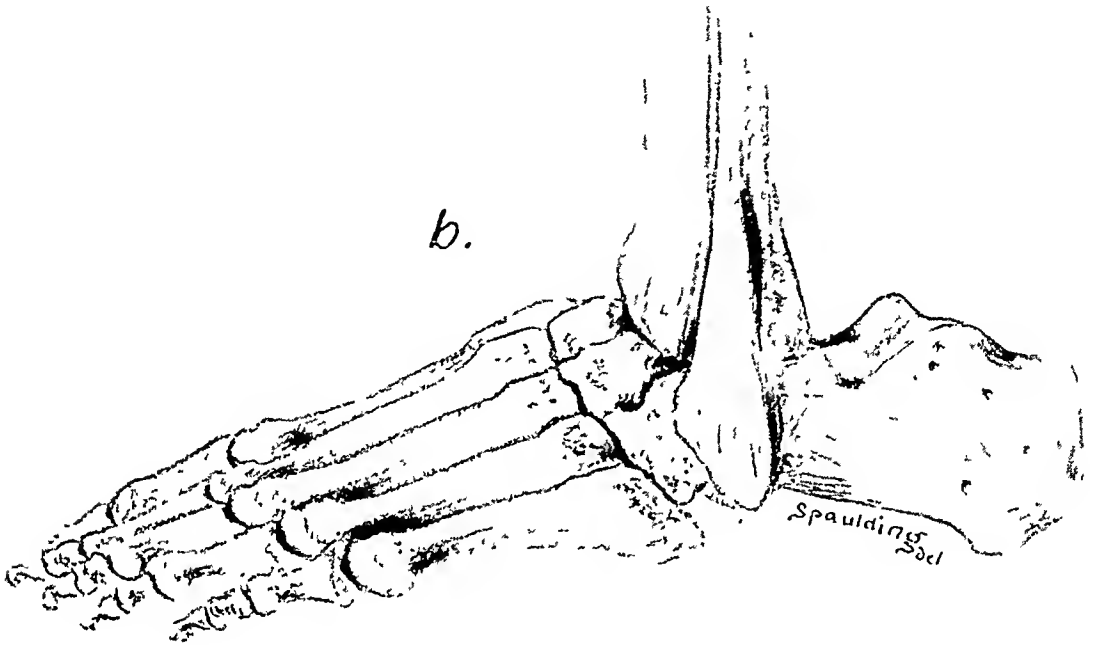


FIG. 12b.—Relations following the properly done astragalectomy.

usual technic and a plaster case applied with the foot displaced backward, and in slight valgus and equinus.

June 24, 1919.—The case above the knee was removed.

July 22, 1919.—A light plaster case was applied from the toe to the knee, and the sole reinforced with the foot at a right angle.

September 2, 1919.—A new case was applied. This was removed on October 28, 1919.

January 6, 1920.—The left leg was one and one-half inches shorter than the right. A one and one-fourth inch lift was worn under the heel, one-half inch of which was on the inside of the shoe. A one-inch lift with one-fourth inch inside the shoe was worn on the sole.

Result: March 1, 1921.—Exam'nation showed an excellent result.

CASE III.—B. P. Age seven. Calcaneovalgus deformity. *Complaint:* Slight limp and turning of left ankle. *Duration:* Three to four years. *Cause:* Infantile paralysis. When the patient began to walk she had difficulty with balance.

Physical Examination.—Walked with marked pronated feet and heel was wobbly. Good dorsiflexors. Excellent peronei. No inner or posterior group. Astragalectomy with transplanting of peronei into the Achilles advised.

Treatment: May 1, 1923.—Astragalectomy was performed without transferring the peroneal tendons. Plaster applied in toe-drop, to be changed in three weeks.

May 31, 1923.—Case was removed and a new one applied. There was a slight serous discharge.

June 21, 1923.—There was still some sloughing. The patient began to walk on the case and bend the knee.

August 21, 1923.—The case had been removed when the seab fell off, and was replaced by a flannel bandage. The foot was at a right angle. There was 10° to 15° motion.

November 13, 1923.—Foot at a right angle. Massage advised to increase circulation. A one-quarter inch wedge put under heel to compensate for shortening.

December 11, 1923.—Walks with eversion of left leg, but with good foot balance. About 25° motion. No pain. Excellent displacement. (Figs. 17, 18, and 19) *Result:* Good.

CASE IV.—M. C., Age six. Calcaneovalgus deformity. *Complaint:* Foot turned



FIG. 13.—Disposition of the tendons of the peronei into the tendo-Achillis.

out. *Duration:* Three years. *Cause:* At three years of age patient had infantile paralysis which left her unable to walk. She gradually recovered, but the left foot did not respond to treatment and its condition grew worse.

Physical Examination.—The child walked with marked valgus of the left foot. The anterior tibial and peronei were present, although the former was weak. There was no Achilles or posterior tibialis. The left leg was one-half inch shorter than the right.

Treatment: May 24, 1913.—An astragalectomy and transplantation of the peroneals into the tendo-Achillis was performed according to the usual technic.

Result: December 22, 1914.—The functional result was good. The left foot was in good position.

CASE V.—M. O'B. Age eight years. Calcaneovalgus deformity. *Complaint:* Deformity of the right foot. *Duration:* Six years. *Cause:* Infantile paralysis.

P. I.—July, 1913. The patient entered the out-patient department with history of having had anterior poliomyelitis six years before. When first seen she complained of a limp and deformity of the right foot.

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Physical Examination.—Negative except for the deformity of the right foot. The examination showed the absence of the inner and posterior groups of muscles. (Fig. 21.) The patient was advised to enter the hospital for operation. A regular astragalectomy was performed, including the transplantation of the peroneal tendons into the Achilles and os calcis.

The convalescence was managed in the routine manner, and was uneventful.

Result.—The end-result was excellent. Calcaneovalgus deformity. *Complaint:* CASE VI.—E. D. Age eight years. *Duration:* Four years. *Cause:* Infantile paralysis. Deformity of the left foot.

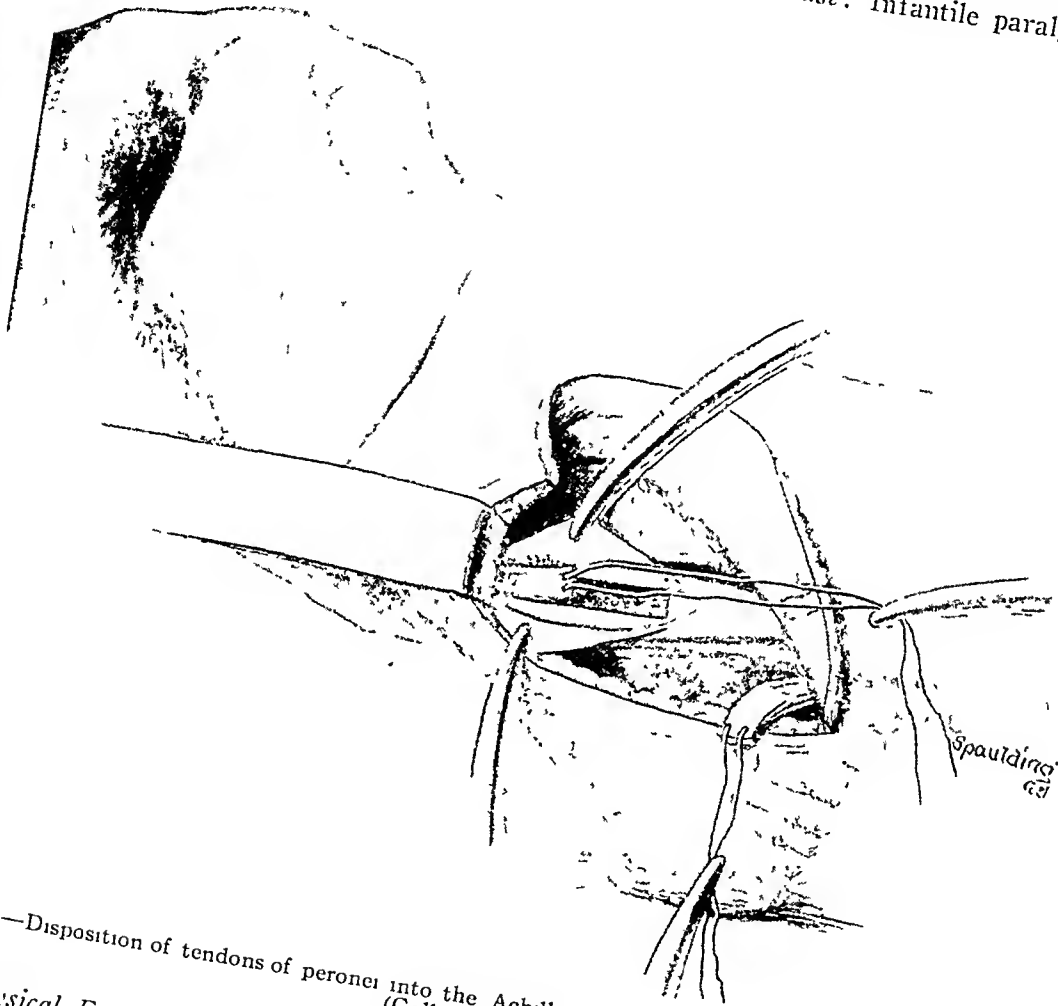


FIG. 14 —Disposition of tendons of peronei into the Achilles tendon and resuture and tendon fixation (Gall operation).

Physical Examination.—There were no contractures. The gastrocnemius and plantar flexors were absent. The quadriceps, anterior tibial and peroneal muscles were in good condition. There was shortening of one and one-half inches. The left foot was in calcaneovalgus deformity.

Treatment.—In December, 1914, an astragalectomy and transplantation of the peroneal tendons into the tendo-Achillis were done.

Result: January 22, 1924.—The foot was at a right angle and in excellent posterior displacement and good alignment. There was 10° motion in the mid-tarsal joint. The patient was wearing a lift under the heel and sole of shoe.

CASE VII.—C. V. A. Calcaneovalgus deformity. This patient had a calcaneovalgus deformity on the left foot, due to infantile paralysis. A regular astragalectomy was done.

Result.—The result was good, with posterior displacement of foot in good alignment.

CASE VIII.—K. M. Age four. Valgus deformity. *Complaint:* Left foot deformed. *Duration:* One year.

Cause.—Infantile paralysis. The onset was sudden; the patient on getting out of bed was unable to walk.

Physical Examination.—The child walked with a marked valgus of the left foot. The peronei were present. There was no anterior tibial. The tendo-Achillis was slightly

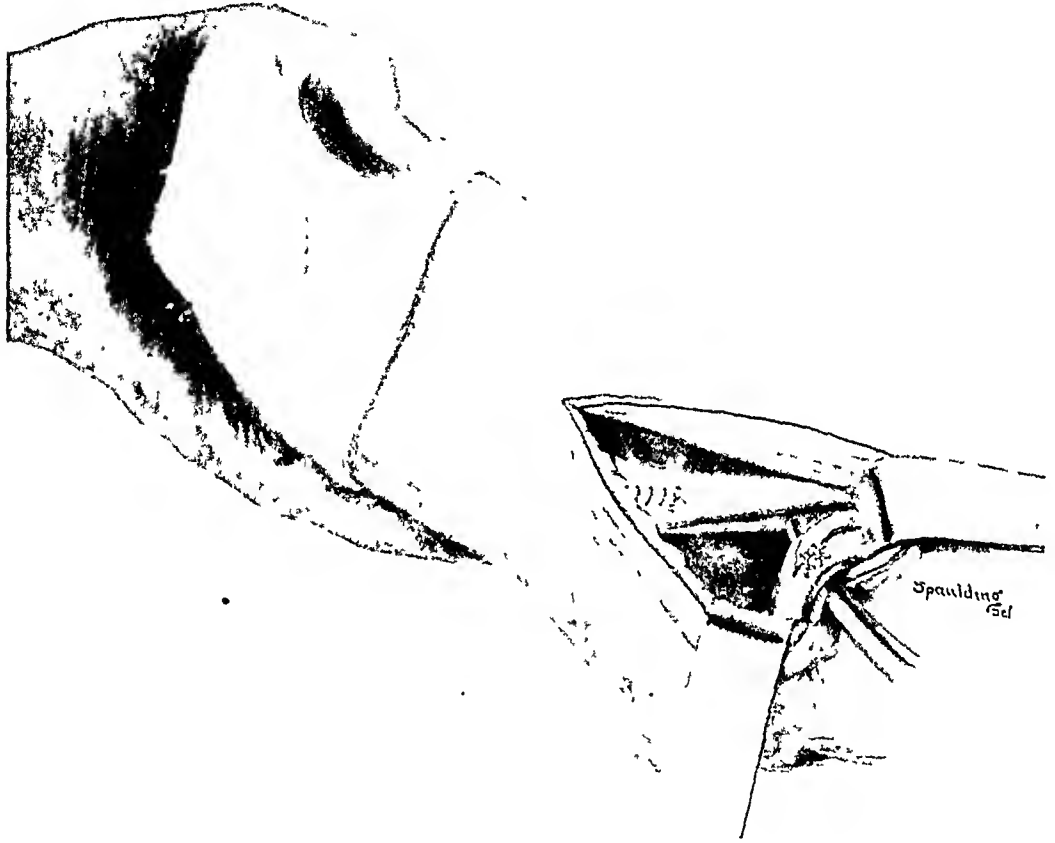


FIG. 15.—Disposition of tendons of peronei into Achilles tendon, and resuture of ends

contracted. Abduction of the foot was not possible. The entire left leg was markedly atrophied.

Treatment: April 19, 1913.—A regular astragalectomy with transplantation of the peronei into the os calcis was done.

Result: June 4, 1915.—An excellent functional result was obtained. She walked well; motion from 85° to almost 180° was possible.

CASE IX.—J. H. Age thirteen. Valgus deformity. *Complaint:* Walked with left limp. *Duration:* About twelve years. *Cause:* Infantile paralysis at the age of twenty-two months.

Physical Examination.—Left foot in marked valgus. Slight power in the extensors and Achilles tendon. No power in the tibialis anticus. (Fig. 20.) Glutei very weak.

Treatment: June 24, 1919.—Astragalectomy according to the regular technic.

August 5, 1919.—New case applied with the foot at a right angle. Patient began to bear weight.

November 18, 1919.—Case removed.

ASTRAGALECTOMY

December 19, 1919.—Foot in fine condition. The patient was wearing a shoe with a one and one-half inch lift under the heel.

March 20, 1920.—The patient stood with the foot in slight valgus. The leg was two and one-half inches shorter than the right. A one and one-fourth inch bevelled lift was worn under the sole of the shoe, of which one-fourth was worn inside the shoe.

May 25, 1920.—The patient walked very well with shoe. Exercises begun.

Result: June 21, 1921.—An excellent result. The foot was at right angles, and there was good displacement and good control. There was flexion of 25° . (Figs. 21 and 22.)

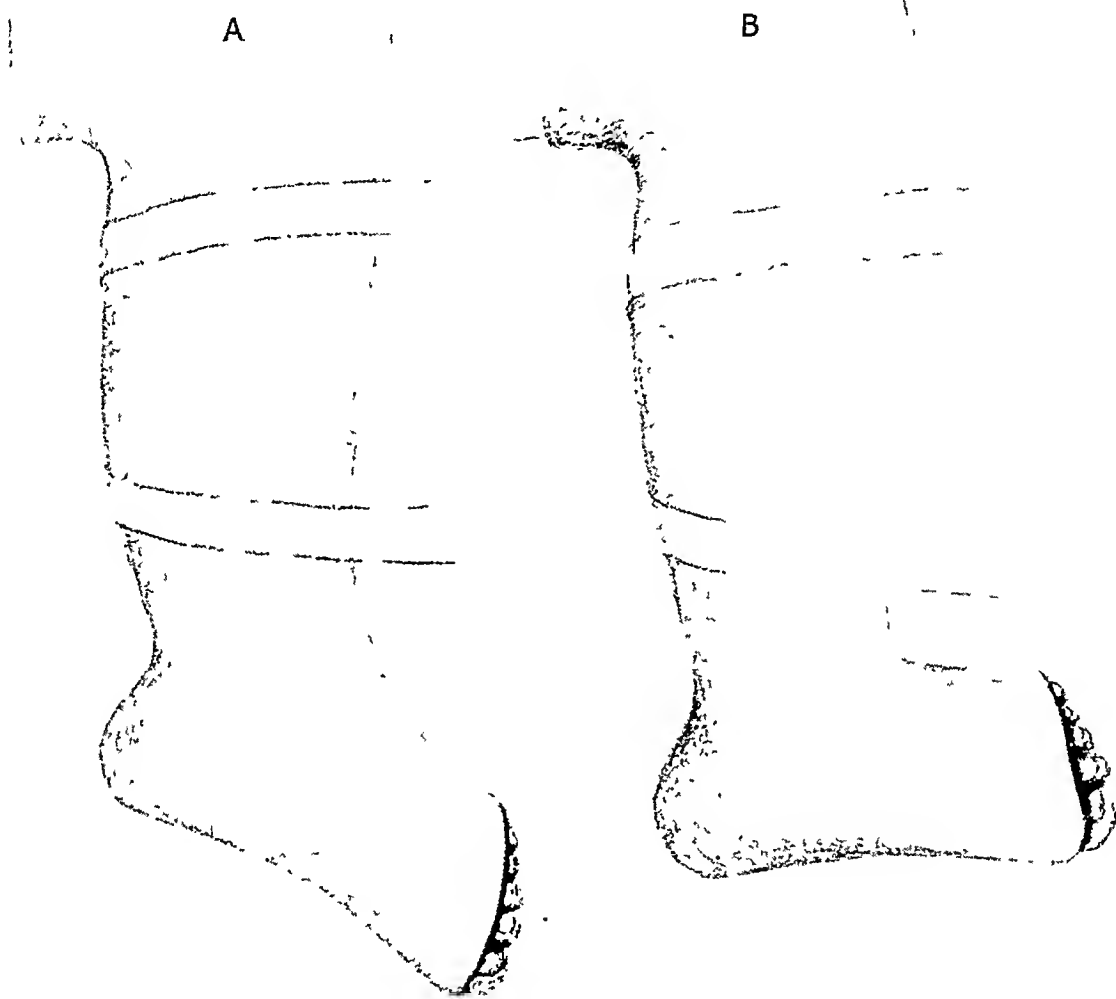


FIG. 16.—In plaster, following operation.

CASE X.—C. H. Age nine. Varus deformity. *Complaint:* Lameness. *Duration:* Six years. *Cause:* Infantile paralysis.

At three years of age this child had a fever which was followed by paralysis of the right foot that resulted finally in a varus deformity.

The foot was manipulated and the deformity corrected into a slight valgus.

On account of the general muscular weakness of the foot, as well as the absence of the peronei and the anterior muscle group, as astragalectomy was performed.

Two years later there was 25° motion in the ankle-joint. The foot was in good position and the patient walked splendidly. There was good stability and no pain.

CASE XI.—C. S. Age sixteen. Talipes equinus (extreme). *Complaint:* Lameness. *Duration:* Thirteen years. *Cause:* Infantile paralysis.



FIG. 17.—Case III, B. P., calcaneo-valgus deformity. Anterior view after astragalectomy (Whitman).

At three years of age this patient had a "fever" resulting in loss of use of the right leg. Improvement followed, but the right foot remained in extreme deformity.

Physical Examination.—Negative except for the contraction of plantar fasciae and the Achilles. The peronei were present. The leg was one and three-eighths inches shorter than the left leg. The diagnosis was made of extreme talipes equinus, due to anterior poliomyelitis. The foot was manipulated and the plantar fasciae contraction was first corrected.

May 19, 1914.—A regular astragalectomy was done, followed by the application of plaster from toe to just above the knee.

June 30, 1914.—A new plaster case was applied from the toe to the knee with the foot at a right angle. Several changes were made later, and the patient was allowed to walk on plaster with a three-eighths wedge under the heel.

July, 1915.—The functional result was good. There was good valgus, and the motion at the ankle was good.

CASE XII.—L. M. Age fourteen. Calcaneocavus deformity. *Complaint:* Walks with left heel limp. *Duration:* About twelve years. *Cause:* Infantile paralysis at the age of twenty months.

Physical Examination: August 7, 1923.—The left foot was in slight cavus. The leg, especially the calf, was atrophied. The iliopsoas, quadriceps and the tibialis anticus were strong. The gastrocnemius and the peronei had no power. (Fig. 23.)

Treatment: October 17, 1923.—Astragalectomy was done together with tendon fixation of the flexor longus hallucis to prevent plantar flexion deformity of the great toe.

November 27, 1923.—Ninety degrees to thirty degrees extension was possible.

January 22, 1924.—The case was removed and a flannel bandage applied. Massage of the calf was begun. The patient began to bear weight and was to begin walking as soon as possible, without a lift in the shoe. (Fig. 23.) Note posterior displacement.

Discussion of Doctor Sever's Report of Cases.—Our end-results are so different from those reported in Doctor Sever's¹⁸ series, that it is interesting to try to explain the factors which account for the differences. We believe there are three:



FIG. 18.—Case III, B. P., calcaneo-valgus deformity. Lateral view after astragalectomy. (Whitman.)

1. *Failure to correct the structural deformity before operation.* One hundred and eighty-eight cases had deformity, but no mention is made of its correction before astragalectomy. Sixty-five cases had varus deformity, which should always be corrected before operation.

2. *Lack of proper operative technic.*—(a) Failure to remove the head of the astragalus. X-rays accompanying the report show that the head of the astragalus has not been removed. This fact is not noted in the report.

(b) Failure to displace the foot properly. Sever admits failure due to lack of displacement in thirty-five per cent. of the fifty-four cases on which there is a note.

3. There are several factors in the operative technic on which Doctor Sever did not seem to be clear. The operation was originally designed for the calcaneus

type of deformity, yet only fifty-two of the two hundred seventeen cases were of this type. The operation was also designed for cases involving paralysis of the gastrocnemius, but it was used in sixty-nine cases in which the gastrocnemius was active. Sever also appears to have anticipated a stiff ankle, which is not the aim of astragalectomy. Sever believed that the equinus position was



FIG. 19.—Case III, B. P., calcaneo-valgus deformity. Degree of motion after astragalectomy (Whitman).

the one sought by the operator, but this is true only in the absence of a quadriceps and even then only 5° to 8° toe-drop is advisable. In "Table No. 5" Sever records one hundred eight cases as having good "lateral movement." The object of the operation is to establish stability by limiting the lateral motion.



FIG. 20.—Case IX, J. H., valgus deformity. Lateral view before astragalectomy (Whitman).

Sever and his operators have failed in all the above essentials and their end-results might have been anticipated. We believe, as does Whitman, that the end-results and tabulations reported by Sever are of little value.

Literature.—Astragalectomy was first reported in the records of the Hospital for Ruptured and Crippled Children in 1897. Whitman²² designed

it for calcaneus deformities of advanced degree, but its application has been broadened extensively and in a series of sixty cases reported more recently by Doctor Whitman²¹ only sixteen were calcaneus deformities.



FIG. 21.—Case IX, J. H., valgus deformity. Anterior view after astragalectomy (Whitman).

Whitman's results certainly corroborate the value of this operation. Armitage Whitman,²² in 1922, issued his report on a series of sixty cases, extending over a period of five years. Twenty-eight of these cases were operated upon by Royal Whitman and thirty-two cases by other surgeons. Ninety per cent. of the patients were satisfied with the results; sixty-five per cent. discarded braces. The best results were secured in calcaneus deformities. The causes of failure in their order of frequency were: insufficient backward displacement of the foot, varus deformity from faulty technic, persistence of the original deformity, and removal of the support of the head of the astragalus from the scaphoid.

Doctor Whitman bases the success of his operation on the proper selection of the cases, a thorough understanding of the mechanical principles on which the operation is based, exact operative technic, and appreciation of the deformity before operation, and of the recurrent distortion.

The Whitman operation has many advocates. Dane and Townsend¹ have reported three successful results, one for calcaneus deformity, and two for calcaneovalgus deformity. Gibney,⁶ Taylor²⁰ and Albee¹ are in favor of it. Bradford² has found in his experience in the Boston Children's Hospital that the Whitman operation has given the best results.

Tubby,²¹ Lord,¹⁰ Reed,¹⁵ Campbell,³ Rogers,¹⁷ Orr,¹⁴ and Gillette and Chatterton,⁷ and Henderson⁸ endorse the Whitman operation enthusiastically, particularly for talipes calcaneus.

Other surgeons have found astragalectomy of value in other deformities. Nathan,¹² and Henderson⁸ consider that calcaneovalgus is corrected most efficiently by the Whitman



FIG. 22.—Case IX, J. H., valgus deformity. Lateral view after astragalectomy (Whitman).

operation. Gallie,⁵ too, recommended it for extreme cases of calcaneovalgus and also for dangle-foot; Roberts¹⁰ has secured many good results in typical dangle-foot. Stern and Cook¹⁰ have reported that out of two hundred fifty

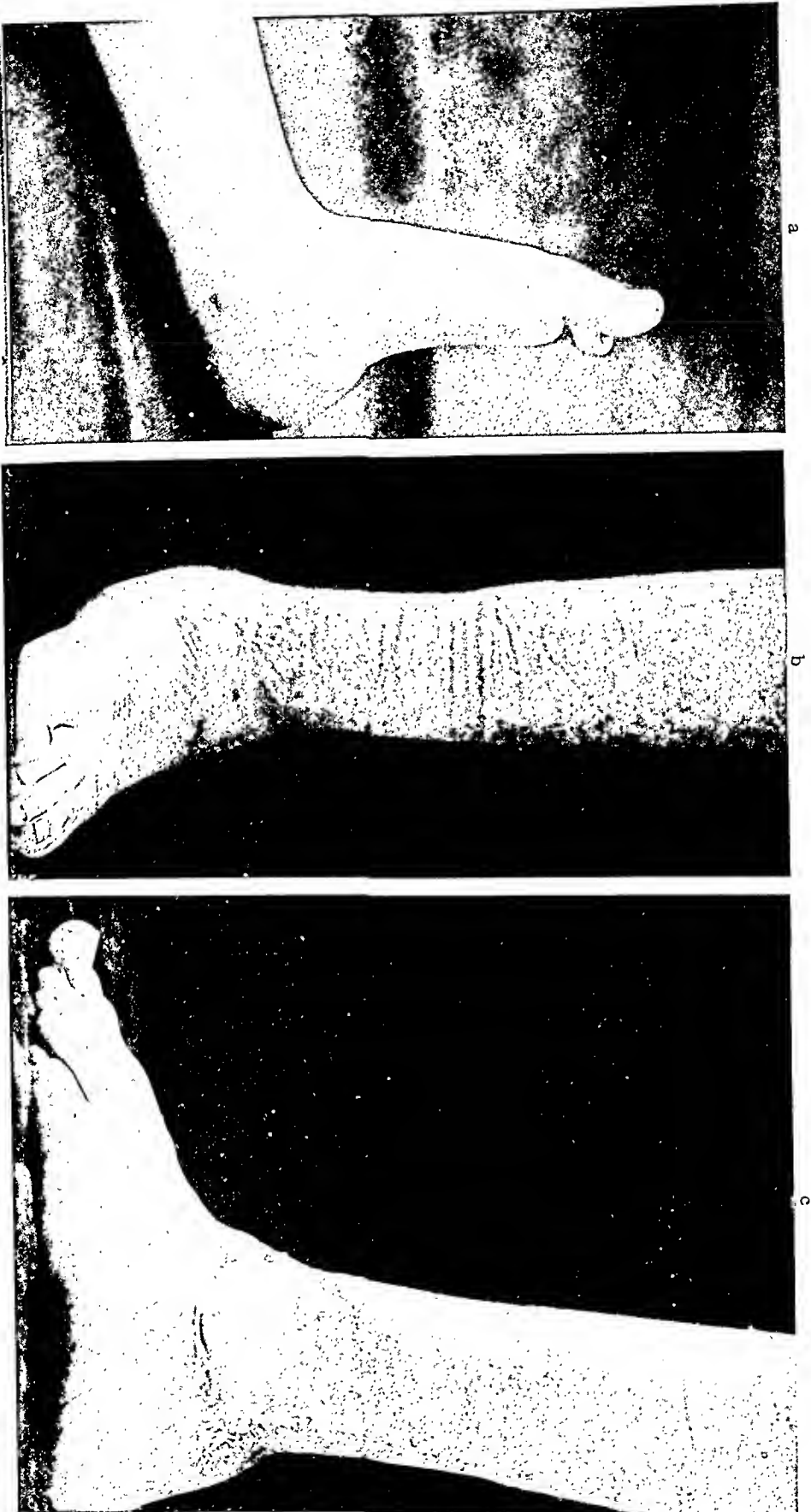


FIG. 23.—Case XII, L. M., calcaneocavus deformity. a, lateral view before astragalectomy. b, anterior view after astragalectomy. c, lateral view after astragalectomy (Whitman).

cases of astragalectomy that they investigated, only twenty relapsed and these could be corrected by a secondary operation. They recommend the operation particularly for paralytic talipes, talipes calcaneocavus, flail and dangle-foot in children ten to fourteen years of age. Packard¹⁴ reported eight successful cases, six of flail ankles, one of marked calcaneovalgus, one of everted foot with toe-drop.

In discussion of Hoke's paper⁹ on the arthrodesis operation, Wallace advocated the Whitman operation, particularly for calcaneous, calcaneovalgus, and dangle-foot. He has used or observed it in one hundred fifty to two hundred fifty cases and there has not been a case in which the patient was not materially benefited. He does not consider age a barrier to the operation, but believes that interference should be made two or three years after the original onset.

The many good functional and cosmetic results obtained from properly performed astragalectomy account for its acceptance as the operation of preference. It has gradually replaced many other operative procedures that have been devised to increase function in paralytic conditions of the foot.

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RADIUM IN THE TREATMENT OF PROSTATIC CARCINOMA*

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1. *Method of Radium Treatment.*—Both Young and Bumpus have, in their reported cases, attempted to and succeeded in confining the radium application to a carcinomatous prostate to one series of treatments, extending over at most a number of weeks. Their treatment has been rectal, intra-prostatic, by needles and intra-urethral. In this way, 1900 to 2500, and even 4000 or 5000 milligram hours, have been given within a short time—weeks. Our routine at the Memorial Hospital is perhaps no better, but certainly quite different. We give the radium by needles, introduced through the perineum, placing the needles 1 to 2 cm. apart throughout the carcinomatous prostate, and passing other needles up into the seminal vesicles. These latter are sometimes introduced through the rectum, and so into the seminal vesicles, the angle of introduction being often better through the rectum. The dosage varies with the size of the tumor, but at one time rarely more than 800 mc. ours are given, and generally less. If there is urethral invasion, screened radium (silver $\frac{1}{2}$ mm.) is used in the catheter, the dose being about 200 mc. hours. Bare tubes of radium are not used in the prostate, as they cause undesirable slough and pain.

This completes the treatment in from two to three months. A slow sclerosis of the carcinoma goes on during this period. The patient, instead of having to go through a period of recovery from his radium treatment, which seems to us inevitable, when the larger doses are given, is encouraged to get stronger, to exercise, so stimulating the production of any natural barriers he may have within him. And this last is very far from a theoretical consideration. Many patients, if they live long enough, seem to reach a more or less stable condition, as far as their cancer is concerned, and improve in health and strength. Every two or three months radium treatments are repeated until in cases which react well, the prostate is a sclerosed mass. Such cases, we all know, are only too rare.

Recognizing the low percentage of actual cures by radium or operation of carcinoma of the prostate, it would seem that this gentler and more occasional treatment were better.

2. *Urinary Obstruction in Advanced Cases.*—One of the most interesting problems of prostatic carcinoma is the management of urinary retention in cases in which the growth is extensive. These patients have a short lease of life, at most two or three years, and living may have become intolerable to them, because of the frequent and painful urination, or the impossibility of

* Read before the American Association of Genito-urinary Surgeons, May, 1924.

urinating at all. In such cases a major operation is to be avoided, if possible. Young has employed the Bottini operation in four such cases, with distinct palliation of symptoms. We have employed an even simpler method. The Young punch instrument has been modified, the length of the opening in the instrument made three times the original size. In this way a much larger piece can be punched out of the bladder neck. We routinely make three or four punches of the lower part of the bladder neck. This operation has been used in 13 cases. The average age of patients operated upon was sixty-two years, the oldest seventy-five, and the youngest fifty-two years.

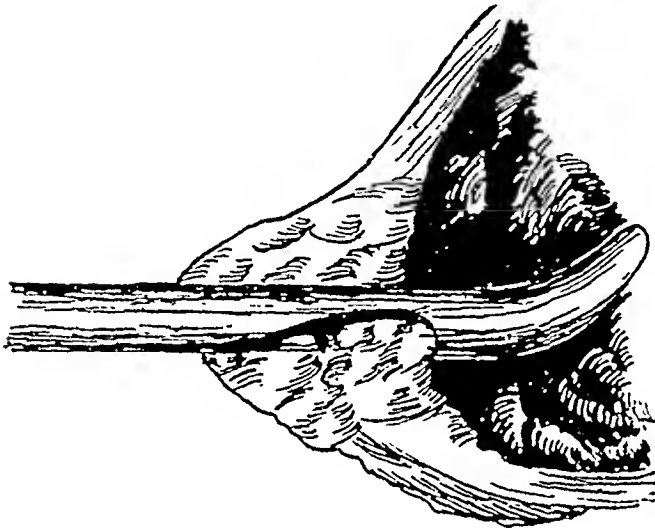


FIG. 1.—Modified Young punch instrument. The opening in instrument is three times that of original.

Residual urine varied from 60 c.c. to complete retention. In 12 cases the residual urine diminished, and in one case did not. In 4 of the 12 cases the operation reduced the residual, respectively, from 90 c.c., 120 c.c., 120 c.c., 210 c.c., to none. The operation seems to work best where there is complete retention. In 4 such cases the residual fell, in 1 case to nothing; in 1 to 15 c.c., and in 2 to 60 c.c. There were 4 other cases in which the

residual was cut in half, but the patients still retained enough urine to cause frequent, and in most cases, painful urination. Therefore, the operation succeeded in 8 of the 13 cases, 61.6 per cent., and failed in 5 of 13 cases, 38.4 per cent. When it does fail, I believe the only thing left is permanent suprapubic drainage.

Duration of Life After Operation.—One died in 16 days from uræmia; the operation undoubtedly hastened his death. Two died in 5 months, 1 died in 7 months, 1 in 8 months, 1 in 12 months, 1 in 13 months. Six are still living. Four for 5, 9, 13 and 18 months post-operation, and 2 are recent cases.

Pathology.—Of 12 cases the examination of the removed specimen showed carcinoma in 11. In 1, normal prostatic tissue. One of the cases showed an epidermoid carcinoma of the bladder, the primary lesion, with a prostatic carcinoma secondary.

3. *Cure of Prostatic Carcinoma by Radium.*—From October, 1915, to January, 1917, we saw 46 cases of prostatic carcinoma at the Memorial Hospital. In but one of these cases was the carcinoma confined to the prostate. Five of these 46 cases lived more than five years. In none of these 5 cases, when last seen, was there any gross evidence of active carcinoma. Therefore in 11 per cent. of this first series was the carcinoma controlled, and possibly

RADIUM IN PROSTATIC CARCINOMA

cured. We see at the Memorial Hospital very few cases in which the carcinoma is confined to the prostate—2 per cent., according to our records. I believe that our later records of possible cure are not quite as good as this first series. It seems conservative to say that with radium treatment from 5 to 10 per cent. of cases of carcinoma of the prostate may be cured. A short résumé of these five cases is of interest:

CASE I.—J. D., age fifty-seven, first seen October 15, 1915, carcinoma of prostate, extending somewhat beyond prostate. Diagnosis with Doctor Keyes. No specimen. Treated only with radium needles, four times, at intervals of about three months each. In perfect health five years and three months after first seen, then lost track of.

CASE II.—A. S., age sixty-six, first seen October 10, 1916, prostatectomy by Doctor Keyes. Pathological examination showed carcinoma of low malignancy. Treated only with radium needles three times. Five years later developed urethro-rectal fistula from radium needle; well, before this, seven years after first seen.

CASE III.—M. P., age sixty-four, first seen April 2, 1917. Prostatectomy by Doctor Downes, at St. Luke's Hospital, January, 1916. Section showed carcinoma. Seen one year after operation with nearly complete obstruction at bladder neck. Treated only with radium needles in prostate three times and dilatation. Six and a half years later is well, barring $\frac{1}{2}$ to 2 ounces residual urine.

CASE IV.—J. H., age fifty-five, first seen July, 1917, hard and irregular carcinoma, left lobe around into left vesicle. Diagnosis with Doctor Keyes. No specimen. Treated twice with radium needles. Well, six years and six months later.

CASE V.—J. C., age seventy, first seen February, 1916. Early case, with some question of diagnosis. Diagnosed by Doctor Keyes as carcinoma. Doctor Beer questionable. Later examination because of enlargement around seminal vesicles, and diagnosis seemed to be assured. His first symptom was a complete retention of urine. Treated only with radium needles in prostate twice. Well seven years and nine months after first seen. No recurrence of retention.

4. *Bone Metastases in Carcinoma of the Prostate.*—I have reviewed the radiographs in 44 cases of extensive carcinoma of the prostate. The radiographs taken were as follows:

Lumbar spine, pelvis, upper end femur.....	39 cases
Lumbar spine, pelvis, upper end femur and dorsal spine.....	1 case
Lumbar spine, pelvis, upper end femur and chest.....	2 cases
Lumbar spine, pelvis, upper end femur, dorsal spine and chest.....	1 case
All bones and chest, 1 case.	

Metastases as follows:

No metastases	32 cases, 72.7 per cent.
Metastases	10 cases, 22.7 per cent.
Suggests metastases	2 cases, 4.5 per cent.

This percentage of metastases very well agrees with Bumpus's figures.

Situation of metastases:

Lumbar spine and pelvis	10 cases
Dorsal spine	1 case
Hilum lungs and lumbo-sacral spine	1 case

In most of the cases the metastasis was of the sclerosing hyperplastic or productive type, so different from that so often seen, in bladder carcinoma, the rarifying type. In 11 cases there was shown hypertrophic, osteo-arthritis. In 2 of these 11 cases the carcinomatous metastases were shown.

It is our routine at the Memorial Hospital to take a radiograph of the



FIG. 2.—Instrument for taking specimens from prostate.
Diameter of shaft 3 mm. (.113 in.)

lumbo-sacral spine, pelvis, and upper femur, unless there is a special indication to take other regions. This, as a rule, will show the metastases, if they be present. On the other hand, in one of the above cases the

metastatic growth was in the fifth dorsal vertebra alone. In this case we should have missed it without the radiograph.

5. *Diagnostic Needle*.—The original needle used at the Memorial Hospital is somewhat smaller than the one now used. If the present needle is well taken care of, and is sharp, we can get a specimen of the prostate in practically every case. The needle is routinely used in cases in which the diagnosis is in question. It has been of value not only in diagnosing carcinoma, but in differentiating tuberculosis of the prostate from simple prostatitis. Recently we have had two cases in neither of which did I believe carcinoma to be present. I was simply suspicious that it might be. With the diagnostic needle, a specimen was obtained and a diagnosis of carcinoma was made in both cases. These are the two earliest cases we have seen in six months.



FIG. 3.—Enlarged cutting end of Fig. 2. Cutting edge must be kept keen.

Summary.—The best method of treatment in our hands has been by radium needles inserted into the prostate and seminal vesicles, this repeated every two or three months until sclerosis of the carcinoma occurs. If there is urethral invasion, urethral treatment is added, to the needle treatment. The modified punch operation has been used in 13 cases of extensive prostatic carcinoma to overcome urinary retention. It was used successfully in 61.6 per cent. cases, and failed in 38.4 per cent. Five cases out of the first 46 seen have gone more than five years with the carcinoma apparently under complete control. All of these cases were treated solely by radium needles.

In from 5 to 10 per cent. of cases, the carcinoma ought to be controlled by radium. Bone metastases occur in our cases in 27 per cent.

The diagnostic needle developed at the Memorial Hospital enables us to make an accurate diagnosis in a much larger percentage of early cases, and is used routinely in the diagnoses in question.

THE INDICATIONS FOR OPERATION IN THE TREATMENT OF TUBERCULOUS CERVICAL LYMPH GLANDS*

A PRELIMINARY REPORT

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AMONGST a large number of clinicians both here and abroad, reaction against surgery places on the defensive, the advocate of operation for tuberculous glands. On the continent of Europe, non-operative treatment (other than the use of an aspirating needle) is decidedly in favor. This influence has been largely responsible for the present conservative attitude toward the disease in America. The use of X-ray therapy, the systematic application of sunlight, the importance of eradicating foci of secondary infection, like the teeth and the tonsils, and indeed in this country, the feeling that tuberculosis is on the wane, have been strong factors in the decline of radical surgery.

A few years ago, medical students were quite generally taught that the standardized treatment for tuberculous glands of the neck was radical excision. The surgical wards of our hospitals then bore evidence of the weight of this teaching. The problem was then simple because it was standardized. Statistics were available on the operative results so that we knew about what to expect from operation. Coincident with the gradual abandonment of radical surgery by large numbers of the profession, the standardized treatment has disintegrated. A generally accepted standard does not exist. The disease to-day is treated by numerous methods—here by one method and there by another—and often with brilliant results; yet this individuality of method, in distant geographical points, has tended to confuse our minds in outlining the treatment of a given patient.

Tuberculosis of the cervical glands in itself is not a serious disease. It is often a self-limited disease. The chief complaint of the patient is either the deformity of a swelling, or the annoyance of a persistent sinus. The aim of treatment is a good cosmetic result which shall be permanent. The aim

Seven years ago this month, in October, 1917, a special study of tuberculous glands was undertaken at the Presbyterian Hospital, New York. During this period over three hundred patients with the disease have been examined and treated; and most of them have been followed. The diagnosis of tuberculosis has been proven in the majority of the patients, while in the others it has been accepted only on satisfactory clinical evidence. The work has been limited almost exclusively to New York City people of small means, and represents an attempt to help them, with the opportunities available, to their greatest economic advantage. The problem would be easier and the results, better were it undertaken where air and sun are ideal as in the Swiss Alps, on a favorable seacoast, or in Southern Arizona.

* Read before the New York Surgical Society, October 8, 1924.

During the first five years, we concentrated upon the effects of repeated small doses of filtered X-ray—a popular method of conservative treatment. From this X-ray part of the study we have drawn certain definite conclusions.

During the past two years, we have enlarged the scope of treatment hoping to raise the percentages of success over the results with the X-ray treatment. We now do everything we can for the patients, including selected operations.

This article deals with the operative indications and we hope that a report upon this part of our present working plan may help to formulate a general standard of treatment.

Let us for a moment first briefly examine some of the observations made after analyzing the X-ray results. These have been reported before the Saranac Lake Medical Society, but not yet published. The method of analyzing the main results was twofold: first, the results in the patients as a group, irrespective of their detailed neck pathology; and secondly, the results in various types of tuberculous neck lesions.

The five main types of lesions were classified as follows:

1. Enlarged firm swellings of less than 2 cm. in diameter.
2. Enlarged firm swellings of 2 cm. or more in diameter.
3. Cystic, or faintly fluctuating swellings.
4. Definitely fluctuating swellings—cold abscesses.
5. Sinuses.

It was found, taking the group of 141 patients, as a whole, treated with relatively frequent small doses of filtered X-ray, that 70 per cent. of these patients showed either apparent cure or such marked improvement as to justify conservative treatment. Thirty per cent. were failures. The results with the five main types of lesions were as follows: Conservative (X-ray) treatment appeared satisfactory in 78 per cent. of the small sized, firm swellings; in 72 per cent. of the large sized firm swellings; in 40 per cent. of the cystic swellings; in none of the cold abscesses as such; and in 76 per cent. of the sinuses. Eighty-five per cent. of the patients were followed after the last X-ray treatment for periods from a few months to four and one-half years.

Thus the small sized swellings and the sinuses responded best to conservative treatment. Some of the cystic swellings did resolve, but most of them became cold abscesses. The cold abscesses either opened spontaneously or were incised when spontaneous opening appeared to be inevitable. It must be stated that besides X-ray treatment these patients received personal supervision of their general hygiene, attention to possible foci of infection, cod-liver oil and whatever simple aid seemed advisable in ambulatory, New York City patients. Sunlight, artificial light, systematized rest, tuberculin, life in the open air and operation were not used to any significant extent.

Combined treatment appeals to us as better than X-ray treatment alone. We are trying to determine the indications for the different therapeutic methods, particularly for operation.

TREATMENT OF TUBERCULOUS CERVICAL LYMPH GLANDS

A number of different elemental points are to be considered in deciding questions of operation in a given case. They are (1) the anatomy and (2) the pathology of the neck, (3) general considerations of the patient, and (4) the operative procedures available.

I. *The Anatomy of the Neck.*—This is discussed under two headings, the regions involved by the diseased glands and the important structures which may be damaged by operation. There are fourteen important regions of lymph-gland disease (Fig. 1):

1. The parotid or preauricular region containing both superficial and deep glands, both of which are frequently involved.
2. The facial or supra-maxillary region, rarely involved.
3. The submental and suprahyoid, the glands in which are most commonly involved with the anterior submaxillary lymph-glands. Region 4 includes the anterior, middle and posterior submaxillary lymph-glands. These are frequently involved, both singly and conjointly. Region 5 is the commonest location of all for tuberculous glands and is also usually the earliest. It includes most of the upper deep cervical (upper jugular) glands with the so-called tonsillar gland, better termed the "subangular" gland, below the angle of the jaw. Region 6 lies beneath the upper part of the sterno-mastoid muscle and contains the highest of the upper deep cervical group. Regions 7 and 8, include the more isolated, posterior auricular and suboccipital glands which are, like the chain in the posterior triangle, all relatively superficial as in regions 9 and 12. Regions 10 and 11 contain the lower deep cervical glands lying along the internal jugular vein. A high percentage of these lower deep cervical glands which have enlarged backward. The involvement of the axillary glands (region 13) in tuberculosis belongs to the extension simply to another group of cervical glands, except in such patients as have tuberculosis of the upper limb, the

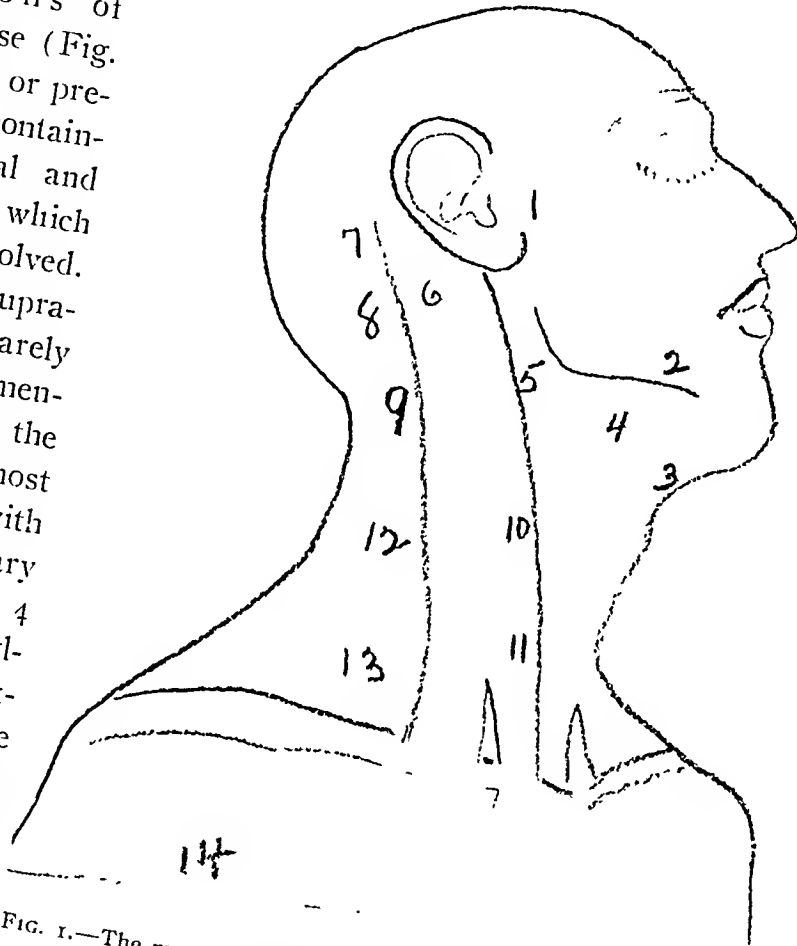


FIG. 1.—The main regions of the neck (with the axilla) involved in tuberculosis of the lymph-glands.

chest wall or the breast. Tuberculous glands are rarely adherent to the axillary vein, so that their removal is not commonly attended by risk to adjacent structures.

The Six Important Neck Structures.—1. The main branches of the facial nerve are not exposed to damage by operations in this disease except in the parotid or preauricular region (1).

2. The submaxillary branch of the facial nerve supplying the muscles of the lower lip as Farr¹ has demonstrated, lies beneath the superficial layer of the deep fascia running well below the body of the lower jaw. It is exposed to damage in regions 4 and 5.

3. The spinal accessory nerve lies deeply placed beneath the upper part of the sterno-mastoid, and is exposed to damage in regions 5 and 6. Particularly in region 6 is it in danger, because it may become adherent to the enlarged overlying nodes. It is then often difficult to identify. When cut or damaged in this region both sterno-mastoid and trapezius muscles are paralyzed, occasionally with a distressing result. Apparently the nerve need not be divided to cause the paralysis. Trauma and subsequent fibrosis may do so. In regions 9 and 12 the accessory nerve again becomes susceptible to injury in its path from the sterno-mastoid to the trapezius.

4. The internal jugular vein must be protected in its whole extent in order to avoid troublesome bleeding. In region 11, where the vein is less easily accessible (unless the muscle be cut), and also less easily mobilized and retracted, bleeding may indeed be dangerous.

5. The subclavian vein is exposed to damage in regions 11 and 13, where enlarged glands tend to extend backward beneath the muscle becoming adherent not only to the internal jugular vein, but also to the subclavian. Bleeding from this vein may prove serious.

6. In regions 11 and 13, too, the thoracic duct may inadvertently be divided or opened.

Aching shoulder is occasionally seen following a simple biopsy in the posterior triangle when the accessory nerve is thought to have escaped injury. The cause of this is not known. One theory is that it is due in some way to division of the descending cutaneous branches of the cervical plexus. Temporary numbness of the face, ear and neck following division of the upper cutaneous branches of the cervical plexus usually is inevitable and of only slight importance.

In certain parts of the neck there are features that appear to favor resolution without excision. It is noticed, for example, in the supraclavicular region (13) that conservative treatment is more successful than in region 5. The glands in region 13 are by nature almost completely immobilized; they are protected by the clothing from handling and from cold; they are far removed from the common foci of infection above. Conservative (non-operative) treatment here, therefore, is justified because it is more successful, because from the cosmetic viewpoint it is less imperative and because excision

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endangers important structures. The constant motion of the axilla, however, militates against resolution here (region 14).

II. *The Pathology of the Neck.*—In a previous paper¹ attention was called to the applied pathology of the disease. Mention has already been made of the five main types of lesions. Since then a sixth type, "diffuse, firm swelling" has been added, so that now the list is as follows: 1. Enlarged, firm glands of less than 2 cm. in diameter. 2. Enlarged, firm glands of 2 cm. or more. 3. Diffuse, firm swelling. 4. Cystic or faintly fluctuating swellings. 5. Cold abscesses or definitely fluctuating swellings. 6. Sinuses.

The smaller glands have a better prognosis than the larger ones with conservative treatment. Diffuse, firm swelling is rarely suitable for operative treatment. The cystic swellings are separated because they have a fair chance of resolution without softening, under conservative treatment, whereas a more definitely fluctuating lesion, a cold

abscess, has very small chance of resolution, without sinus formation. These various types of lesions may occur singly or may occur in any number of combinations in two or more of the fourteen main regions.

Dowd,³ in 1916, treated the working pathology by describing three groups of cases. These are explained best in the diagram (Fig. 2). His "group 1" corresponds to any of our first five types if located in region 5. "Group 2" corresponds to group 1 which has developed a sinus, or to group 1 which has extended into our regions 6, 8, 9, 10 and 12, with any of our first five types of lesions. "Group 3" includes those patients with extensive cervical tuberculosis having any of our types of lesions and usually with evidences of tuberculosis in other parts of the body. The neck infection in group 3 involves a great number of nodes and displays all types of lesions.

An analysis of the neck pathology must be made in every patient before outlining the plan of treatment. As the course progresses this plan of treatment is always open to change dependent upon the variations in the neck

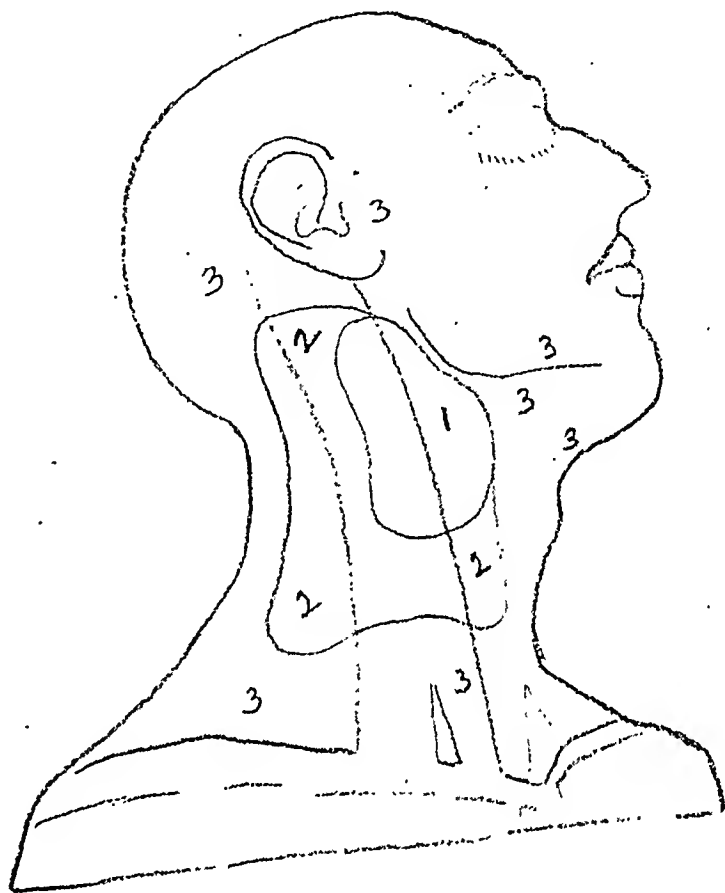


FIG. 2.—A schematic representation of the three groups of Dowd. Group 3 includes Groups 1 and 2.

pathology. The operative indications may be quite different after the period of conservative treatment from what they were at the start. X-ray therapy, for example, tends to disperse a diffuse, firm swelling and to isolate localized swellings suitable for excision. We have found that X-ray therapy does not appear to increase the difficulty of the simple excisions used in our plan of treatment. An abscess may be incised in one stage of treatment and later, the remaining lesion (perhaps a sinus or a small firm mass), may be suitable for excision. If we discount general considerations we always have certain definite local findings capable of analysis for the outline of treatment. These local findings are based upon the six main types of lesions and upon the fourteen main regions. We may also have to reckon with such questions as the removal of an old scar and the extent of coincident pyogenic infections. With all this knowledge, then, at hand, there is some approach to a formula for operative treatment.

III. *General Points Relating to the Patient.*—Age. A common conception of tuberculosis is that of infection in early childhood, of distribution manifested in later childhood, and of extension or of recrudescence in later years in parts previously invaded during the stages of infection and of distribution. Broadly speaking, the forces of resistance increase with age. To operate upon a tuberculous lesion in a child under five years of age predisposes that child to distribution, the most striking example of which is tuberculous meningitis. It may be safe to make this rule, therefore, that with a child under five, the only operations permitted are the simpler ones of aspiration and of simple incision of cold abscesses and perhaps occasionally of gentle curettage.

Race. It has seemed to us that the Negro and the Chinese in our series have relatively low resistance or a relatively high state of hypersensitiveness, or both, and that with them at all ages, greater caution is needed in operating upon tuberculous lesions for fear of inducing distribution or extension and recrudescence elsewhere.

The forces of resistance. Besides age and race, the signs of good nutrition and good health are the important ones. Resistance should reach its maximum at the end of the period during which all the well-known and accepted methods of conservative treatment have been employed. This, then, is undoubtedly the safest time for operation. But practically in the majority of cases, operation is indicated in a much earlier stage of the treatment period, usually indeed at the very start, as we shall soon see.

Active tuberculosis elsewhere than the neck or axilla. As a general rule, the non-cervical tuberculosis takes precedence so that the whole plan of treatment depends upon the needs of the more important lesions. The commonest one, of course, is pulmonary tuberculosis. This main principle usually may be followed, that only operations of the simpler class are indicated upon the neck in patients with active disease within the chest or abdomen. More radical steps occasionally may be taken in the neck in the case of coincident external lesions in patients over seven or eight years of age.

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Hypersensitiveness. In patients with tuberculosis of the neck, a state of hypersensitiveness may exist in the presence of any of the following conditions: (1) Fever, whether due to active tuberculosis anywhere in the body or due to pyogenic or other infections in the neck or elsewhere. (2) Active tuberculosis elsewhere than the neck even without fever. (3) Within two months of a definite tuberculin reaction, as from too large a dose in treatment. (4) Within two months of an operation of the more extensive class upon tuberculous tissue anywhere in the body. (5) Within two months of a definite reaction of a large dose of X-ray treatment which possibly acts like an overdose of tuberculin. These are largely theoretical, but nevertheless worthy of thought in deciding questions of operation upon tuberculous tissue. While tuberculosis in the neck is not a serious disease, there is almost certainly some degree of intoxication exerting variable effects upon the general health and upon the heart, the liver, and the kidney.

The condition of possible foci of infection draining into the cervical lymphatics. The tonsils—shall they be removed before, during, or after an operation upon the neck? It is impossible to make rules covering all cases. There are two or three points of interest. It is probably unwise to let anything take precedence over the excision of a suitable neck lesion partly softened. On the other hand, it is gratifying to feel that the infection of the cervical glands by the operations upon the upper diseased foci has run its course and done its work before we attack the disease in the neck. Let the tonsillectomy, the tooth extraction, the radical mastoidectomy have their utmost effects upon the neck lymphatics before the final neck operation be planned. If the tonsils or adenoids prove to be tuberculous, it is probably safer to postpone the neck operation two months after their removal. They should always be examined after removal. With general anaesthesia it is usually advisable to do the simpler operations upon the neck under the same anaesthesia used for the operation upon the upper foci of infection; but for the extensive excisions in regions 4, 5, 10 and 14 (Fig. 1), the neck operation should be done at a separate time—afterwards if there is no softening beforehand.

The patient's choice. From our conclusions of the study of conservative treatment the chances of recovery without operation for different types of the disease can be estimated with an approach to accuracy. These, together with the operative statistics of Dowd,³ give a good basis from which to conclude that careful excisions plus the conservative (non-operative) methods of treatment give better results in most of the early cases than does the conservative treatment alone. By better results we imply the main objects of treatment—safety, permanence, speed and appearance. The patient or the guardian must be given the information that no known plan of treatment can insure a cure; that recurrence may at any time appear no matter what be done; that complete excision in a given region may be followed immediately by new local or distant neck swellings; that operations of the more extensive class may inadvertently cause nerve damage; that well-planned incisions may

end in keloidal scars; and that after operation definite treatment and supervision are advisable over many months' time. The scars of the different types of operation must often be compared with each other and they must also be compared with the scars of existing sinuses and of spontaneous openings. Though operation be decided against at one time, the question should always be left open for the future. If operative scars be dreaded, reassurance can be given in the favorable effects upon them of the X-ray and light treatments.

IV. *The Available Operative Procedures.*—There are seven; and they are discussed in the order of their probable value as an aid to cure.

1. Complete excision of a lesion or of a group of lesions. Excision of a tuberculous lesion in any part of the body is the best method we have to attain a positive cure. The limitation to conservative treatment in pulmonary tuberculosis is after all but a makeshift because excision is impracticable. We can never be sure of having achieved a complete excision because of the uncertainty of involvement of surrounding or adjacent lymphatics; but no combination of conservative methods of treatment can assure destruction or permanent quiescence of tubercle bacilli.

Complete excision is the most fundamental part of treatment from the standpoint of cure. Excision is more likely to be complete if done before liquefaction-necrosis has thinned out the boundaries of the affected parts, and it is also more likely to result in a good cosmetic result, a clean linear scar. Therefore in the locations where complete excision is permitted this is the operative indication, and especially so with the large sized glands. But if liquefaction be detected the case at once becomes a surgical emergency so that excision shall precede the thinning out of the boundaries. This applies to the small as well as to the large glands. A few days delay will often entirely alter the favorable prospects of cure and of the linear scar. The detection of fluctuation, therefore, in an excisable region, indicates the need of excision within forty-eight hours as a general rule. If the patient be first seen when the skin is already thinned out, the same urgent need of early operation is demanded, so that whatever operation be selected it shall precede spontaneous rupture, with the consequent inevitable contamination of the part by secondary infection. Thus in the regions favorable for excision, we have two types of lesions calling for expedition in their operative treatment, cystic swellings and cold abscesses. They should not be kept waiting for a convenient time nor for an empty bed in a hospital. They need the considerations of an emergency.

The best follow-up results discovered for any method of treatment of tuberculous cervical glands are those of the large series of Dowd,³ with whom 91 per cent. of patients in group I remained cured after excision. The key-notes to his success were early diagnosis in the early stage with early complete excision. If we add to excision in selected cases the conservative forms of treatment, may we not be approaching an ideal for our generation? Complete excision, however, is limited to certain regions of the neck for one main reason, namely, because endangering the important neck structures is not

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justifiable in the face of the favorable results obtained by more conservative treatment. A "bloc-dissection" of the neck for this disease is by this token alone never justifiable. Moreover, one can never foretell that such an extensive procedure will not be too great a drain upon the patient's resistance.

2. Excision of a part of the disease in a given region. This may be permitted at times provided the line of excision does not traverse gross tuberculous tissue. For example, it seems occasionally preferable to leave inaccessible glands during an attempted complete excision than to endanger important structures. The impression is that the removal of the bulk of the disease in a part favors the subsequent healing of the remainder. It is not ideal but it is safe, and when combined with the other forms of treatment offers a good prospect of cure. Procedures 1 and 2 are applicable to any type of lesion in any of the regions suitable for excision, provided the cleavage plane remains outside of the gross disease. The two main reasons for not keeping the cleavage plane outside of the gross disease are the dangers to important structures and the possible magnitude of the procedure. It is said that incomplete excision leads but to a persistent sinus. The reply to this is that 76 per cent. of our sinuses healed with conservative treatment.

3. Partial excision with curettage. The use of this procedure implies the presence of necrosis to the extent that the cleavage plane of an excision cannot be kept outside of the gross disease. Curettage is then substituted in part for excision.

4. Incision with curettage. Excision of a cold abscess is always preferable to curettage, as an ideal procedure. But if a cold abscess be too extensive or if the boundaries be too friable; if it lies in a region unsuitable for excision; if the skin be too extensively thinned out, then curettage through a small incision provides a safe method of removing the bulk of the disease with a minimum of risk and scar. Curettage may be practiced with varying degrees of gentleness and thoroughness depending upon the local and general conditions. A cold abscess often consists of a double or of a triple cavity formation wherein the superficial cavity signals deep-seated disease. Thorough curettage reaches all of the cavities, and if necrotic material be well removed, it may facilitate the ultimate healing, but blind force in reaching inaccessible pockets is to be avoided.

5. Incision. Incision alone without curettage is the simplest operative procedure next to aspiration. It is applicable only to the cold abscesses. Incision alone is indicated in the larger abscesses, especially in young children and in patients who may be hypersensitive to the toxins of tuberculosis. It is satisfactorily done with local anaesthesia. Aspiration has been a disappointment in our series of nerve blocking or general anaesthesia. Aspiration has been a disappointment in our series of patients. Like simple incision it is limited to fluctuating lesions. Experience has led to the following conclusions:

a. It is safe and it leaves no scar. b. There are no positive contraindications to it *per se*. c. It may turn the tide toward resolution of cystic swellings and of cold abscesses during the course of conservative treatment. d. If successful, it is less likely to involve the skin and to leave a sinus than is incision. e. It does not so completely empty the cavity as does incision and by no means so completely as incision with curettage. f. Usually it must be repeated one or more times—more frequently than incision. g. Even when successfully carried out it usually fails to effect the resolution of a cold abscess. h. When it does result in apparent resolution, local recurrence is more frequent than with any of the other operative procedures for softened lesions. i. It is more distressing than simple incision because so much pressure is needed even with a nick in the skin to introduce a large needle at a distance from the involved skin. Success is mainly dependent upon a large needle. j. It fails in those lesions which though fluctuating are not fluid, whereas, through a small incision much of the soft necrotic material can be evacuated by light pressure.

7. Injections and aspiration.¹ The rationale of this practice is that by inducing liquefaction the disease can be aspirated away, giving a cure without a scar. It facilitates one of nature's methods of cure by softening and extrusion. Our studies have not included a trial of this plan of operative treatment so that no final opinion is justifiable. Since it aims at the production of a cold abscess and since our success with the aspiration of cold abscesses has been slight, it does not impress us favorably. It appeals to one as an indirect slow method of incomplete removal. There probably are, however, indications for its use if carefully studied.

The seven operative procedures are divisible into two classes, those which tend to induce distribution and hypersensitiveness and those which do not. In the first class are the three kinds of excision and the thorough curettage; in the second class, the simple incision (perhaps with gentle curettage) and aspiration. They are called respectively the "more extensive" and the "simpler" operations, because of the difference in degree to which they tend to open the lymphatic and the blood-vessels in the diseased region.

If a biopsy be needed to establish the diagnosis, it should be made therapeutic also if feasible.

With a knowledge of the normal anatomy and keeping in mind all the general considerations relating to the patients, it is possible to try to determine what operations are suitable for the different types of lesions in every one of the several regions.

Region 1—parotid. Conservative treatment appears to have a high percentage of success in the firm and cystic swellings. Excision is rarely indicated because of danger to the facial nerve. Incision with curettage (Fig. 3, 1A), simple incision (Fig. 3, 1B) and aspiration are suitable for abscesses.

Region 2—facial. Little experience with this region, on account of its rarity of involvement, justifies impressions only. The firm swelling rarely

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becomes large so that a positive diagnosis is not usually made until softening has occurred, in which case the choice of excision or of one of the less complete operations in each case must be decided. There are no important structures to be damaged but the cosmetic result is important. (Fig. 3, 2).

Region 3—submental. Here there are no structures endangered by radical removal by the best method feasible of any type of lesion, the earlier the better. (Fig. 3, 3.) As a rule, however, the submaxillary lymph-glands (region 4) of one or both sides are simultaneously involved, in which case region 3 may be viewed as an operative part of region 4.

Region 4—submaxillary. The submaxillary branch of the facial nerve to the muscles of the lower lip runs below the margin of the lower jaw beneath the superficial layer of the deep fascia.² A low incision is necessary to avoid cutting it. (Fig. 3, 4.) Excision of the firm and cystic swellings is done through a low incision without permanent damage to the nerve. It does become temporarily paralyzed, often due, perhaps, to traction upon the upper flap in which it lies. Permanent paralysis is an unfortunate disfigurement and should be avoided. It is seen

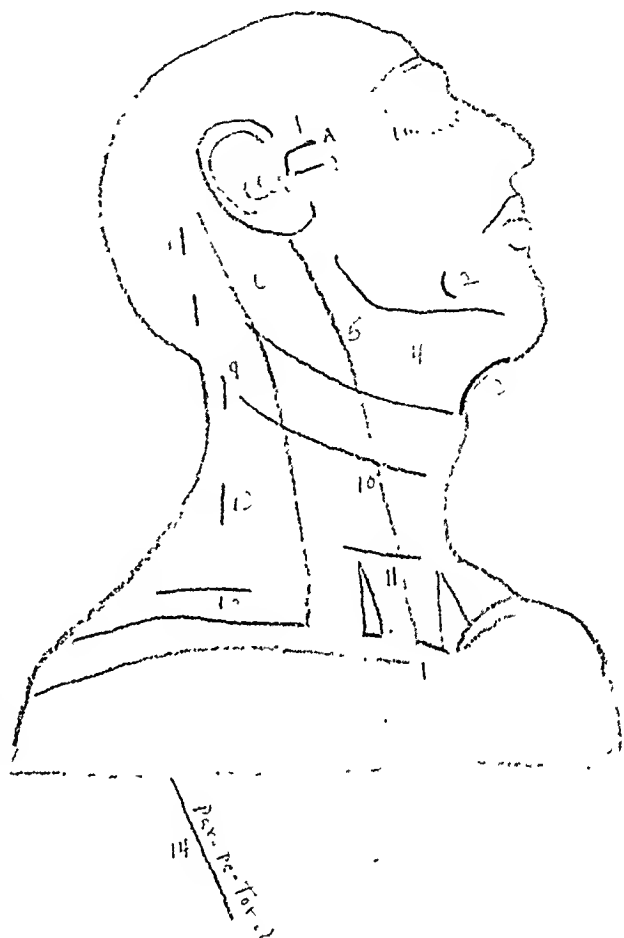


FIG. 3.—The common incisions.

most frequently after operations upon abscesses and sinuses when the nerve has become implicated, before operation, in the skin involvement. In these cases, a low incision is made and a partial excision with curettage is done. The upper flap is gently handled and its under surface lightly curetted with gauze. If permanent paralysis already exists, from a previous operation, then the nerve is disregarded and attempted complete excision is done.

Region 5—subangular. This is the region par excellence for a complete excision of any type of lesion. If the skin be extensively involved or the deep boundaries thinned out, partial excision with curettage may have to suffice. If the adjacent region 6 be conjointly diseased, excision only of that part of the disease in region 5 is done. Dowd says that "very few patients who have thorough operation when in group 1 ever reach group 2." We would reëmphasize the importance of immediate complete excision of all types of lesions limited to this region. The operation is safe; the scar is minimal; and the end results quoted above are highly satisfactory. If the disease be

limited to region 5 the spinal accessory nerve is usually spared with care. In region 5, a low incision is needed to avoid the nerve to the lower lip as in region 4. (Fig. 3, 4 and 5.)

Region 6—deep submastoid. Only the simpler operations are done in region 6. The spinal accessory nerve is spared at any cost. Complete excision is never attempted.

Regions 7 and 8—posterior auricular and suboccipital. The glands here are rarely tuberculous, but if the diagnosis be made before softening occurs, excision is indicated. The regions are safe so that attempted complete removal of any type of lesion is justifiable. (Fig. 3, 7 and 8.)

Regions 9 and 12—the middle part of the posterior, superficial chain of glands. The spinal accessory nerve traverses these regions. Isolated firm and cystic swellings are excisable with care, but the abscess should be subjected merely to the simpler operations. Sinuses may be curetted but their complete excision is hazardous. Paralysis of the trapezius causes aching, deformity and loss of function. (Fig. 3, 9 and 12.)

Regions 10 and 11—the lower deep cervical. In the upper part of this group of glands, in region 10, complete excision is indicated for circumscribed, firm and cystic swellings, abscesses and sinuses, provided there is no involvement below in region 11. Regions 5 and 10, if both are involved, are suitable for a single, complete excision of the whole mass; but if region 11 be involved with region 10, excision of part of the disease may be done, leaving the disease in region 11. Region 11 is dangerous because the disease here tends not only to adhere to the fixed lower part of the internal jugular vein, but also to extend backward beneath the muscle into region 13, becoming adherent to the subclavian vein and to the thoracic duct. Hence only the simpler procedures are indicated in regions 11 and 13. Fortunately their prognosis with non-operative treatment is relatively good. (Fig. 3, 10, 11 and 13.)

Region 14—the axillary glands. Complete excision is indicated with any or all types of lesions in the axilla unless there is the unusual condition of adhesions to the vein or to the plexus. In this case excision of part of the disease is done or, partial excision with curettage. (Fig. 3, 14.)

CONCLUSIONS

1. Operation is indicated in a large number of patients with tuberculous cervical lymph-glands.

2. It is impossible to make rules covering all the combinations of lesions and regions which may be seen in patients with more or less extensive involvement. An adaption of the main principles is worked out for every patient. Early removal of all tuberculous tissue is the ideal; but it must be tempered with an eye to the ultimate appearance of the neck and with safety to the patient and to the important structures. After time and conservative treatment have done their work, a later removal, if needed, is always worthy of consideration.

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3. The results with conservative treatment (including the simpler operations) are so good that only those radical operations are done which are relatively easy and devoid of nerve and vein damage.

4. The more extensive operations are relatively safe in regions 3, 4, 5, 7, 8, 10 and 14.

5. Damage to the nerve to the lower lip is surprisingly frequent in regions 4 and 5.

6. Damage to the accessory nerve is not infrequent in region 5.

7. In Dowd's group 1 (region 5) early complete excision is recommended.

8. In his group 2 (regions 5, 6, 8, 9, 10 and 12) complete excision of the whole mass of disease is replaced by the safer but less ideal procedures as needed according to the lesions.

9. In his group 3 (scattered regions) the same attitude is held as for group 2.

10. Operative procedures are but a part of the whole plan of treatment and may be indicated at any period, depending upon the general and the local conditions.

11. The general and the local conditions are capable of definite analysis.

This preliminary report is presented with the expectation that from its criticism our ideas about operation will become more clear cut and better directed in the continuation of the attempt to standardize the treatment as a whole.

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RUPTURE OF THE DIAPHRAGM *

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IF ONE includes in his definition of hernia only those protrusions from the peritoneal cavity which are covered by a true sac, then the occurrence of diaphragmatic hernia is rather rare. In this paper we shall give to the term *hernia* a broader significance, and include under diaphragmatic hernia both the cases of true hernia where there is a peritoneal sac, and also those cases in which there is an open communication between the abdominal and thoracic cavities through a defect in the diaphragm.

Diaphragmatic hernia in both the traumatic and congenital forms is a condition that has been recognized by surgeons and pathologists for a very long time. But the surgical treatment of the condition is a recent development. The following statement is made in Holmes' "System of Surgery," published in 1881: "We are silent on the subject of treatment. We cannot hope to close the aperture in the diaphragm by any measures which science or mechanical surgery would justify; could we accurately detect the existence of a protrusion it were in vain to attempt its reduction with any benefit to the patient or credit to ourselves."

Unsuccessful attempts to cure diaphragmatic hernia by operation were made by Naumann in 1888 and O'Dwyer in 1889. Naumann's case was strangulated and occurred in a nineteen-year-old workman. He operated through a laparotomy incision. The patient died the same day. O'Dwyer's case was that of a congenital hernia in a child. His pre-operative diagnosis was empyema. The operation demonstrated the nature of his mistake. A subsequent attempt to repair the hernia was unsuccessful and the patient died.

The first successfully operated case of diaphragmatic hernia was that of Postemski in 1889. A boy, fourteen years old, received a stab wound in the left lower thorax, following which a piece of omentum protruded. Thoracotomy was performed, the diaphragm sutured through the thoracic incision, and the patient recovered.

Following this Farinato in 1895 reported a case of strangulated hernia following a stab wound ten months previously, upon which he had successfully operated. In the same year Llobet reported a successfully operated non-strangulated case which followed a stab wound eleven months previously. This case came to operation because of the appearance of a swelling in the eighth intercostal space. The operation disclosed the fact that this swelling contained omentum.

In 1906, Wieting in an interesting publication of what he called the

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"chronic form" of diaphragmatic hernia had the following to say: "There exist very few cases of this nature diagnosed during life; and, if one makes an exception of the case of Llobet, because the hernia made its appearance at the exterior, the case of Heidenhain will be very probably the first case of congenital hernia diagnosed and operated with good results; and mine the first of hernia of traumatic origin which was diagnosed accurately before having been cured by surgical intervention." However, Cranwell accurately diagnosed and successfully operated upon a case of this "chronic" variety in 1906 before reading Wieting's paper, but the case was not published until 1908. Heidenhain's case was reported in 1905. Since then the number of cases have been gradually increasing with each succeeding year.

As a matter of fact the number of cases of diaphragmatic hernia in the medical literature is rather large, although very few of those reported were diagnosed during life. From the clinical records one would be led to believe that the condition is very rare. The pathologists, however, give us a slightly different view of the matter. Lacher in 1880 collected two hundred and sixty-six cases from the literature and arranged them in tabular form. He also reported three cases of his own. Struppler, in 1901, collected five hundred cases from the literature. Giffen, in 1912, increased this number to six hundred and fifty. Scudder, in the same year, wrote upon the subject and stated that there were "about 1000 cases recorded," a large portion of which were discovered at autopsy. One gets the idea from going over the subject in the Index Medicus that the number of reported cases has increased more rapidly since the date of these two papers. The influence of the World War with its large number of traumatic cases has given some stimulus to the subject. Most of the cases reported, however, are congenital hernias of babes or symptomless hernias discovered at autopsy. Of Giffen's six hundred and fifty cases only 15 were diagnosed correctly during life. Scudder's series contained 53 cases that had been operated upon, but of these only six were diagnosed before operation. In 1919, Frank could add only 41 cases to the operative series, while Truesdale in 1921 reported 96 cases that had been operated upon in the years 1918 to 1920. Forty-three of Truesdale's cases were the result of battle casualties. This brings the total number of operative cases reported in 1921 up to 190. However, it is probable that some cases were duplicated in Frank's and Truesdale's series, due to the overlapping of the periods they covered. This would make the total figure somewhat less than 190. But there must have been a number of cases operated upon during the war which were not reported.

The mortality in Scudder's series was 75 per cent. This high mortality rate was due to the fact that most of the cases were operated upon for intestinal obstruction and at operation strangulated bowel was found. According to Truesdale, the present mortality rate in non-strangulated cases is less than 10 per cent. The discrepancy between the total number of operative cases and the number diagnosed before operation would indicate that the

mortality rate might be even further reduced if more attention were paid to an early diagnosis.

Only 10 per cent. of diaphragmatic hernias have a sac. The other 90 per cent. are of the false variety—*hernia diaphragmatica spuria*—in which the herniated organs lie naked in the pleural cavity.

Diaphragmatic hernias are as a rule either congenital or traumatic. However, perforation of the diaphragm may be due to inflammatory process of the digestive tract, gastric or duodenal ulcer, rupture of a subphrenic abscess, empyema, or carcinoma. All congenital hernias are not present at birth, but there is always a congenital weak spot at which point the hernia may later appear. The total number of the latter type probably constitutes a very small percentage of the whole. It is quite likely that all of those hernias which have a sac belong to this group. In the rare condition known as eventration of the diaphragm, in which one entire half of the diaphragm is thinned out, weakened, and displaced upward by the abdominal viscera, we are probably dealing with a congenital weakness of a large portion of the structure. The number of congenital defects of the diaphragm in which part of the abdominal viscera lie free in the pleural cavity is quite large, and these cases often cause no symptoms whatsoever.

The traumatic variety is the one that most interests clinicians as it represents the type in which the clinical diagnosis is most often made, and is also the type in which operative interference is most often necessary. Diaphragmatic hernias of all types occur on the left side in 92 per cent. of the cases, and on the right side in only 8 per cent. There are several reasons for this. In the first place it is quite probable that the liver acts as a buffer and protects the right side of the diaphragm from the impact of the other abdominal viscera. Another factor is the unique fact that stab wounds and gunshot wounds occur more commonly on the left side. This might be explained by assuming that the person inflicting these wounds aims for the heart of his victim. In the case of stab wounds it is quite probable that they occur most frequently on the left side because that is the location in which they could be most conveniently dealt by the thrust of a right-handed assailant. Finally, there are developmental reasons for the more frequent occurrence of diaphragmatic hernia on the left side. Von Bergmann's "System of Practical Surgery" † treats the development of the diaphragm as follows: "According to Hertwig, the chest cavity and pericardial cavity begin to separate from the abdominal cavity by a transverse fold developing from the anterior and lateral wall of the trunk and presenting a free edge in the centre and behind. This is called the septum transversum. After the pericardial cavity has been separated from the pleural cavities by the pleuropericardial folds, other folds develop from the posterior walls of the trunk that unite with the septum transversum and form the posterior portion of the diaphragm. The diaphragm therefore consists of an old ventral portion and a more recent dorsal

† Volume ii, p. 555.

portion. The final condition of the diaphragm is produced by the muscles of the trunk extending inward between the connective-tissue folds. When the dorsal and ventral portions do not become united on one side, a diaphragmatic opening remains which represents a communication between the chest and abdominal cavity." Bayne-Jones, in his interesting article on eventration of the diaphragm, has the following to say upon the subject: "On the right, the liver, growing in the septum transversum, which early separates the pleural and peritoneal cavities on that side, seems to guard the right side of the diaphragm from developmental disturbances. The left side, however, grows in close association with the left lobe of the liver, the stomach and spleen, the pericardial formation, one of the pulmonary ridges, and the pleuro-peritoneal membrane. In addition, the posterior portion of the left side of the diaphragm is the last to close." The reason then is clear as to why developmental defects occur more frequently on the left side.‡

Even where the different muscular portions have met there are not infrequently small gaps left closed only by peritoneum and pleura. One of these is constant in front between the costal and sternal portions of the diaphragm, and is known as the foramen of Morgagni. There is also another one behind, between the costal and lumbar portions, known as the foramen of Bochdaleki. Again, more or less weak spots are left at the openings for the passage through the diaphragm of such structures as the œsophagus, splanchnic nerves and aorta. Hernias occurring through these apertures occur most commonly through the one for the œsophagus, next in frequency through that for the splanchnic nerves, and rarely occur through the aortic opening. Graser § in 1904 stated that no case had been reported as occurring through the opening for vena cava.

The traumatic variety of diaphragmatic hernia is caused by the following types of injuries: By a man being forcibly doubled up with his head between his feet, as in a land-slide; by severe concussion of the chest, as by a fall from a height; by stab wounds of the lower thorax; and by gunshot wounds. The last-mentioned agency was the cause of a large number of reported cases during the late war. Stab wounds also account for a large number of the traumatic variety, while the other causes mentioned are decidedly in the minority.

The following case is considered worth while reporting as having presented certain diagnostic difficulties:

J. D., white, male, aged sixty, janitor at the Hebrew Hospital, fell backwards out of a window at that institution on October 19, 1920 and landed on a pile of coal twelve to fourteen feet below. Several people immediately went to his aid, and when reached he

‡ Since this article was written an interesting paper by Cutler and Cooper on "Congenital Deficiency of the Diaphragm" has appeared. The embryology of the diaphragm is gone into in considerable detail.—See Cutler, E. C. and Cooper, H. S. F., *Archives of Surg.*, Mar., 1924, vol. viii, pp. 506-523.

§ Von Bergmann's "System of Practical Surgery," vol. iv, p. 626.

was found sitting with his back against the wall of the building, pressing his epigastrium with his hands and groaning. He was at once admitted to the hospital. Physical examination on admission—2:15 P.M.—was as follows: Moderate surgical shock. Pulse 96, of good volume, irregular with occasional extra systoles. Temperature (rectal) 98.4° Respirations 28. Blood-pressure: Systolic 98; diastolic 70. He was conscious, but extremely pale, and complained of pains in the left arm and over the left lower chest. He was covered with beads of cold perspiration. There was a minor scalp wound in the fronto-parietal region, but no depression of the skull. The left humerus was fractured at its middle third. The chief interest centred in the chest. There was marked crepitation of the soft parts in the left axilla extending to the base of the chest and posteriorly to the interseapular region. Marked tenderness along all the ribs of the lower two-thirds of the left chest. The percussion note over the entire left chest was tympanitic. Breath sounds were audible but masked by the crepitation of the soft parts. No fluid was made out, but owing to the patient's serious condition a thorough examination was impossible. Examination of the right side of the chest was essentially negative. The heart could not be outlined by percussion and the heart sounds were barely audible, in fact it was difficult to ascertain whether they were actually being heard at all or not. The upper abdomen was held moderately tense, but there was no marked rigidity and no muscle spasm. There were no signs of fluid in the abdominal cavity. No abnormal masses.

A diagnosis of fractured ribs, punctured lung, and pneumo-hæmorrhage was made. On account of the negative signs in the abdomen a ruptured diaphragm was not considered.

The patient was given stimulants and treated for shock. He had to be given morphia on account of the intense pain in his chest. At 7 P.M. the respirations were more labored and rapid, pulse of poor quality, and the patient seemed to be in a stupor. At 1:30 A.M. patient became restless, pulse 70, weak, irregular, intermittent, and he was again given morphia. Pulse became progressively weaker and respirations more labored and he died at 4:22 A.M., about fourteen hours after injury.

Autopsy Findings.—These were negative except for the local conditions encountered. The dome of the diaphragm on the left side was ruptured and the entire stomach, transverse colon and a portion of the small intestine had herniated into the left pleural cavity. The left lung was collapsed. All the ribs on the left side from the fourth to the twelfth inclusive were fractured, the point of fracture in the fourth being about two inches from the spine, and that in the others at increasing distances therefrom, proceeding downward. The sharp perforating ends of these ribs projected into the pleural cavity and perforated both the lung and the stomach. The left pleural cavity contained blood and stomach contents. The right pleural cavity was normal. The heart was displaced to the right. The peritoneal cavity contained neither fluid nor blood, due to the fact that the rupture in the diaphragm was tightly constricted around the neck of the herniated mass of organs. This explains the almost complete absence of abdominal signs after the injury.

The following cases gathered from the literature illustrate the types of cases that are successfully diagnosed and operated upon during life:

GIFFEN (1912), reports a case of a man twenty years old who was caught in a sand-slide and forcibly doubled up with his head between his feet. He suffered intense pain in the abdomen and chest and was confined to his bed for five weeks but no diagnosis was made. During the following year he had attacks of severe epigastric pain at intervals. He then came into Giffen's hands and a diagnosis of diaphragmatic hernia was made from the history of the injury, and the physical signs in the chest, *viz.*: tympany, heart displaced to the right, and distant heart sounds. Operation by the abdominal route showed an opening in the left half of the diaphragm with the stomach, transverse colon, spleen, twelve inches of jejunum and the tail of the pancreas in the left pleural cavity. Lung completely collapsed. The patient recovered and six weeks after operation the lung was almost completely expanded.

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It was noted that during the operation tremendous traction was exerted by the chest cavity on the herniated organs, making it extremely difficult to replace them in their normal habitat. This difficulty has been encountered by other surgeons and is one of the principal objections raised to operation for diaphragmatic hernia by the abdominal route.

In 1914, STUART MCGUIRE reported two cases upon which he had successfully operated. The first case was a male, aged nineteen, operated upon four months after a stab wound of the left chest. The stomach was found in the left pleural cavity. The second case was that of a male, aged thirty-four, who fell a distance of 34 feet from a roof. Following the fall he was in bed for six weeks and when he got up noticed a gurgling sound in his left chest similar to what he had frequently felt in the abdomen before the accident. A year later he went to Doctor McGuire on account of a persistent and severe grade of indigestion and shortness of breath. X-ray after a bismuth meal showed practically the entire stomach in the left pleural cavity. Both these patients were operated upon by the thoracic route, using the Cranwell trap door of the full thickness of the thoracic wall.

In 1915, DAVIS of Birmingham reported five cases, upon four of which he had operated. The first case was seen in 1902, and was that of a stoutly built fireman, who while holding a nozzle on a ladder was suddenly wrenched to one side and severely strained. In Davis' absence he was treated by an assistant for four days without operation, and died. The diagnosis was not made until autopsy in spite of the fact that the abdomen had been rigid from the time of the accident. Autopsy revealed a rent in the diaphragm with the entire stomach and part of the transverse colon in the pleural cavity.

Davis' other four cases followed stab wounds of the thorax and were all correctly diagnosed and successfully operated.

GALE in 1920 reported a case of a man twenty years old, who was struck in the lumbar region by a travelling crane. Although the abdomen was rigid, the heart was displaced to the right, there was tympany over the left chest and distant breath sounds, the diagnosis was not made until the patient was X-rayed. He was operated upon by the thoracic route. A rent was found in the diaphragm, and the stomach, transverse colon and spleen were in the left pleural cavity. These organs were replaced in the abdomen and the rent in the diaphragm repaired. Patient was alive and doing well six weeks after operation, but he also had a comminuted fracture of the 4th lumbar vertebra and the final outcome of the case is not stated in the report.

RANKINE in 1920 reported the case of a boy, eight years of age, who was run over by the hind wheel of a motor bread van. The patient was in great pain and the abdomen was rigid. Immediate abdominal exploration was performed and revealed the presence of a small amount of blood in the peritoneal cavity but no injury to the liver, intestines, bladder or kidneys. However, when the left upper quadrant was explored it was found that the spleen and stomach had herniated into the pleural cavity through a rent in the diaphragm. The abdominal wound was closed and an osteoplastic flap turned back in the axillary portion of the left thoracic wall. The stomach and spleen were replaced and the tear in the diaphragm sutured. Recovery was uneventful and a week later it was noted that there was "evidence of the lung expanding." Examination six years after the accident showed no deformity of the chest wall, expansion good on the left side, and a radiogram showed the dome of the diaphragm to be in normal position.

An example of a diaphragmatic hernia following a perforating gunshot wound of the chest is shown by the following case reported by UNGER and WESKI: The patient was a twenty-nine-year-old German officer, who had a perforating wound of the chest in May, 1915, the bullet entering in the 7th intercostal space. There was immediate healing of the wound without operation and the patient had no symptoms after healing until June, 1916 (thirteen months later) when he began to have pain in the left thorax. These symptoms increased until September when the patient underwent operation. The stomach, pancreas

and a large part of the large intestine were found protruding into the thoracic cavity through a large hole in the diaphragm. These were replaced and the diaphragm sutured. The patient did well for three weeks when he had to undergo a second laparotomy for intestinal obstruction due to adhesions, and four days following this he died. Autopsy showed the diaphragm to be perfectly healed.

The authors explained the course of this man's symptoms by saying that the original hole in the diaphragm was a small one which gradually enlarged and gradually permitted the entrance of more and more of the abdominal organs into the thoracic cavity.

The non-traumatic cases which come to operation are generally operated upon for intestinal obstruction, and, as stated above, the cause of the obstruction in very few of these cases has been diagnosed before operation. However, Stone has furnished an example of the exception to this rule in a case which he recently reported. Diagnosis was made by the physical signs in the chest and the X-ray. Operation was done by combined thoracic and abdominal approach. A loop of bowel was found caught in a small diaphragmatic hernia, and this could not be reduced until the hernia opening was enlarged. The patient made an uneventful recovery.

These cases are illustrative of the types of cases encountered clinically. However, the discrepancy between the number of cases diagnosed clinically and the number of cases encountered at autopsy would lead one to believe that a great many symptoms in chronic patients which are unexplained by the usual diagnostic procedures may be due in certain instances to undiscovered diaphragmatic hernias. The diagnosis of the type of case that we have dealt with here depends upon three things: First, careful inquiry as to previous history of injury; second, the physical examination of the chest; and third, radiographic and fluoroscopic findings.

Conditions which might be confounded with this condition are hydropneumothorax or pyopneumothorax, subphrenic gas abscess, large cavity in the lower lobe of the lung, and eventration of the diaphragm. It is not always possible to differentiate diaphragmatic hernia from these conditions by physical signs alone. The symptoms and physical signs vary with the complications present. There is no typical picture which characterizes the condition, as is indicated by the comparatively few times the correct diagnosis is made before operation or autopsy; but with the aid of a careful history, the X-ray, and the exploratory puncture it is possible to rule out the conditions mentioned above. In hydropneumothorax and pyopneumothorax the coin sign and the exploratory puncture are valuable aids to diagnosis. The X-ray should effectually rule out a large cavity in the lower lobe of the lung, or subphrenic gas abscess. Likewise is the X-ray of great value in differentiating between eventration of the diaphragm and diaphragmatic hernia, the contour of the diaphragm being smooth in the case of eventration and having an irregular protrusion in the case of hernia. Schlippe has given us another differential point between these two conditions, namely, that of noting the fluctuation of intragastric pressure with expiration and inspiration. This

pressure can be determined by suitable apparatus introduced into the stomach. Normally the intragastric pressure rises with inspiration and falls with expiration, but when the stomach lies in the pleural cavity the reverse is true.

As to the treatment of rupture of the diaphragm, operation should be performed as soon as the condition of the patient will permit—at once if there is evidence of strangulation or a ruptured viscus. Some cases are so badly shocked that it is necessary to institute anti-shock measures before any operative procedure can be attempted. Graser || emphasizes the importance of closing the opening immediately and states that experience shows that most injuries of the diaphragm are followed sooner or later by fatal strangulated hernia. He further states that “according to Lacher, of 36 cases of injury to the diaphragm that were not operated upon immediately, 5 died within one day, 10 within a month, 5 within five years, and 5 in twenty years, all of the effects of diaphragmatic hernia.”

Of the two operative routes, namely, the abdominal and the thoracic, the thoracic has two very great advantages. In the first place opening the thorax does away with the intra-thoracic negative pressure and makes it a simple matter to reduce the herniated organs. In the second place, suture of the diaphragm is an easy matter from this approach and may be very difficult, if not well nigh impossible, through the abdomen.

The great advantage of the abdominal route is that of being able to repair any damage to abdominal viscera without making a second incision. It is often necessary, especially in the case of stab wounds, to open the abdomen in order to repair a hole in the stomach or a cut in the spleen, even in cases where the thoracic route has been used for the repair of the injured diaphragm.

An objection often raised to the thoracic route, and a point urged in favor of the abdominal route, is the danger of pneumothorax from the thoracic opening. This argument, however, has little to support it, as the air has equally as good an opportunity to enter the thorax from the abdomen through the hole in the diaphragm as from the opening in the thoracic wall. War experiences in thoracic surgery have largely tended to remove the fear of pneumothorax.

The majority of surgeons who have operated on these cases now seem to consider the thoracic route preferable, even in cases where it is necessary to open the abdomen also to repair abdominal viscera. Stone advocates the combined thoracic and abdominal approach. This method seems ideal, as one has the combined advantages of being able to explore the abdomen, which is nearly always advisable in these cases, and also the technical advantages offered by a thoracic incision. The necessity of making two incisions adds little, if any, to the length of the operation, as this slight increase in the time required is readily offset by the additional ease with which the operation is performed. The advantage of being able to get a hand on each side of the

|| Von Bergmann's "System of Surgery," vol. iv, p. 626.

diaphragm is a considerable time-saving factor. The French have even gone a step further and we find Auvray advocating an incision starting in the thorax and extending down through the abdominal wall, dividing the costal cartilages and splitting the diaphragm down to the hernia opening. Such a radical procedure, however, seems to be unnecessary.

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AN EXTRAPERITONEAL INTRAPLEURAL ROUTE OF APPROACH FOR INTRATHORACIC SURGERY

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THE rigidity of the chest wall is a very essential factor in the physiology of the intrathoracic organs. It is instrumental in keeping up with the negative

intrapleural pressure so that intrathoracic organs function properly. In operations involving the thoracic viscera where the ribs have to be resected, a permanent deformity of the chest wall is produced with subsequent permanent loss of the rigidity of the chest wall. Such a defect impairs normal respiration by mechanically diminishing the vital capacity of the lungs and thus exposing the patients to an added respiratory and circulatory strain. In a previous paper (M. Joannides, Arch. Int. Med., Jan., 1924,

vol. xxxiii, pp. 145-154) it was shown

that in dyspnoëic conditions the ultimate voluntary reserve of increase in the amplitude of respiration becomes diminished in direct proportion to the degree of dyspnoëa. The term "ultimate voluntary reserve" is used to signify the difference in volume of air between the vital capacity and tidal air in conditions of dyspnoëa. If, then, the patient develops heart disease or pneumonia and thus his respiratory reserve is diminished, he will, undoubtedly, either die or else find himself in extreme difficulties when he has a flabby non-rigid chest wall in addition to his heart and lung disturbance. A number of intrathoracic operations such as those performed on the œsophagus, the lungs, the heart, and the mediastinum are frequently life-

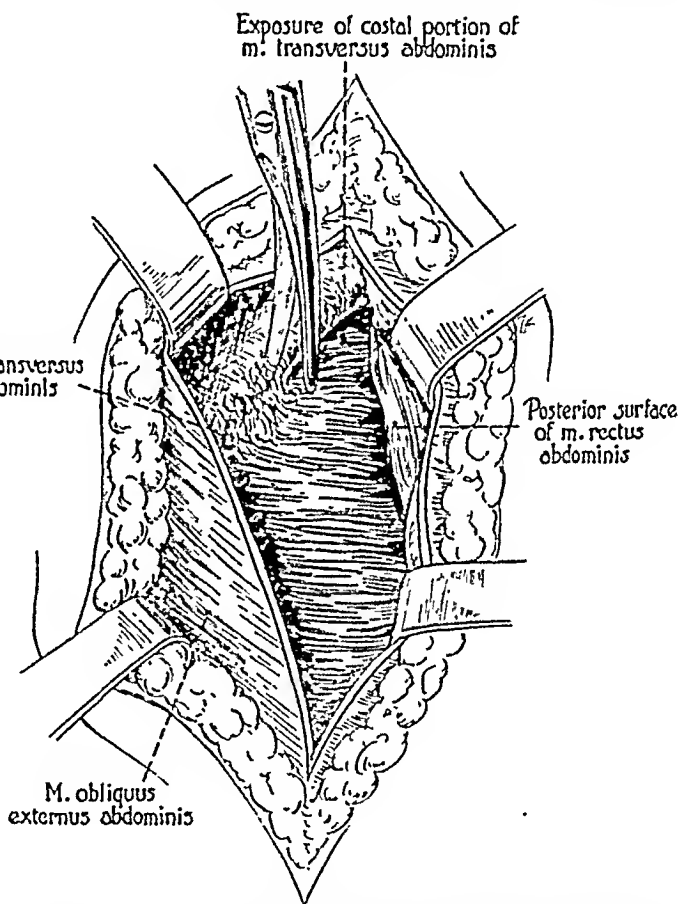


FIG. 1.—Shows retraction of rectus and oblique abdominal muscles. Dissection of costal portion of transversus abdominis muscle before it is incised at its attachment.

APPROACH FOR INTRATHORACIC SURGERY

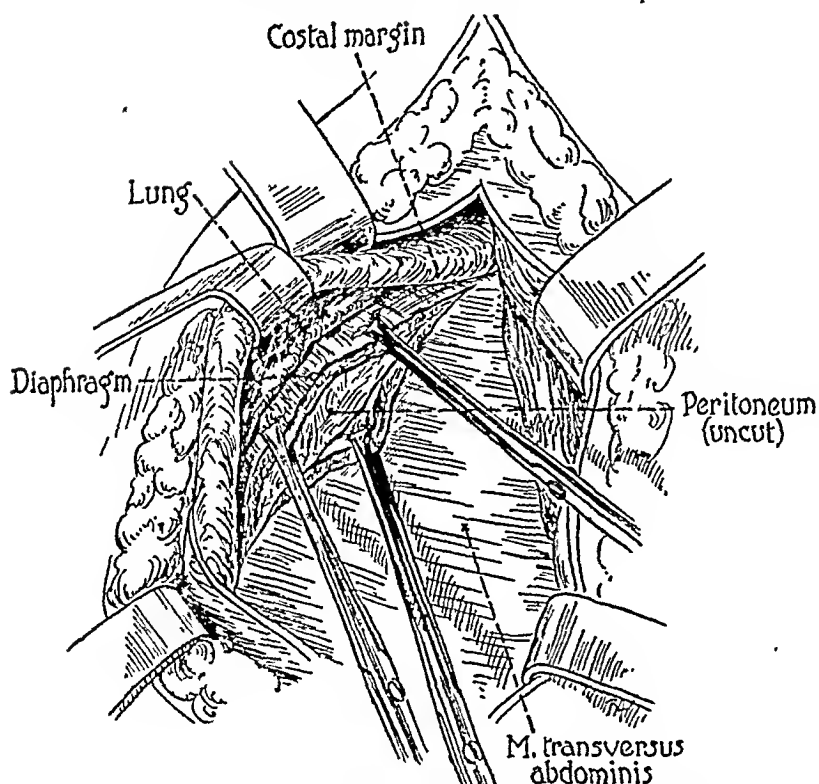


FIG. 2.—Shows cut ends of diaphragm and transversus abdominis muscles with uncut peritoneum coming into view. By lifting on the costal margin, tip of lower lobe of lung comes into view.

thus various types of operations may be performed without the necessity of unnecessary haste which very frequently proves detrimental to the patient.

The Operation.—

A high rectus incision is made and the fascia of the external and internal oblique muscles is incised at the point of the junction to the fascia of the rectus muscle. The muscles are then retracted and the costal attachments of the transversus abdominis are exposed by means of blunt dissection. The transversus abdominis muscle is then incised as close to its costal attachment as possible. At this point the peritoneum may become exposed and care must be taken not to incise

saving measures. Most procedures, however, require resection of one or more ribs in order to get a satisfactory exposure. The route which is described here preserves the rigidity of the chest wall and at the same time makes the various intrathoracic organs quite accessible, particularly those in the lower thorax. With the aid of artificial respiration the pleural cavity may be left open over prolonged periods, and

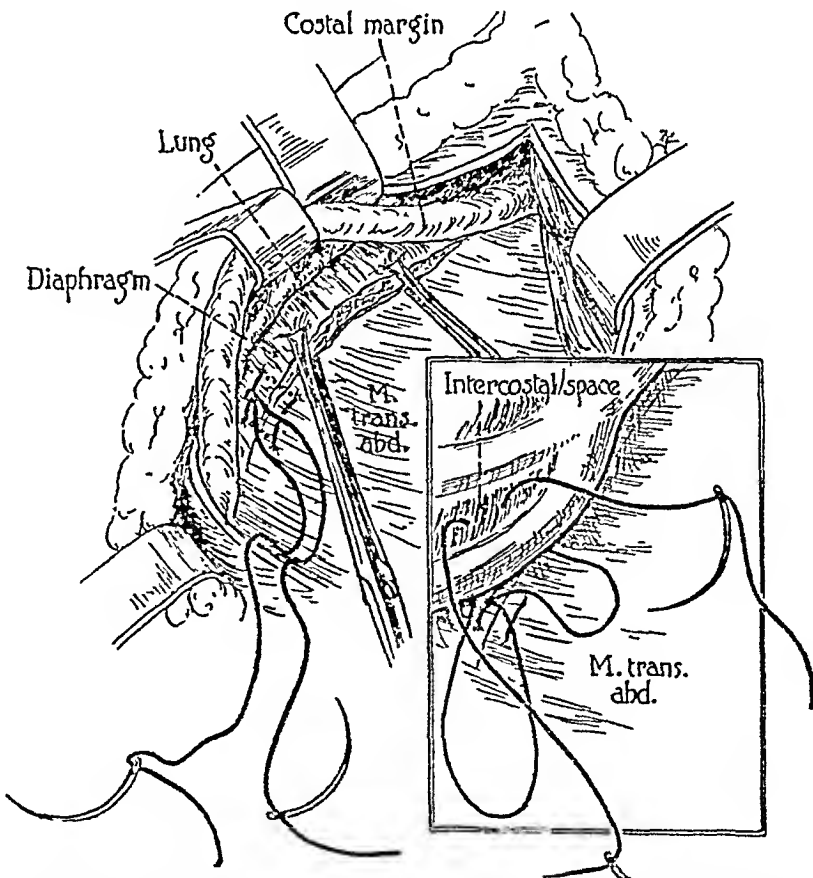


FIG. 3.—Diaphragm is pulled by means of clamps and is sutured to transversus abdominis muscle. Pleural cavity open with tip of lung showing. Insert shows suturing of abdominal muscles to chest wall.

it. By pulling gently the abdominal wall the diaphragm comes into view and this is incised as close to the costal margin as possible. Artificial respiration is now started and is continued until the chest cavity is completely closed. The incision of the diaphragm is enlarged by inserting the finger through the first opening and then cutting as close to the chest wall as possible. The severed end of the diaphragm is now sutured to the cut portions of the transversus abdominis muscle by means of interrupted sutures. This step assures an absolute closure of the peritoneal cavity and at the same time prepares the muscles for hurried closure if that ever becomes necessary. This is done by leaving the sutures long and having needles inserted to each end of the suture and closing the wound by passing the needles through the lowermost intercostal space and tying the sutures. Additional sutures are used to make the pleural cavity absolutely air tight by sewing the muscles to the chest wall at points where air is noticed to enter and go out of the pleural cavity. As soon as the pleural cavity is closed artificial respiration is stopped and the air in the pleural cavity is removed by the use of a Potain aspirator. The abdominal muscles may be sutured in layers in the same manner as any laparotomy. A Gesell-Erlanger (Amer. Jour. Physiol., 1914, vol. xxxiii, p. xxxiii) artificial respiration tank is used to produce positive pressure respiration. This chamber is preferable because it conforms to physiologic conditions of respiration more closely than any other instrument. It is intermittent and the rate of respiration can be regulated by increasing or decreasing the amount of air intake in the chamber.

Comment.—This route is of advantage in intrathoracic surgery particularly in aseptic operations. It offers an easy approach to the lower intrathoracic organs. It preserves the rigidity of the chest wall. Out of twenty-two animals on whom the operation was performed, only two dogs died on the table. In these animals artificial respiration was not satisfactory, with the result that the animals died of asphyxia. Details of the experiments will be given in another paper. The operation is apparently quite harmless because there is very little injury to the diaphragm both from an anatomic and physiologic viewpoint.

ACUTE APPENDICITIS IN THE INFANT

FACTORS ACCOUNTABLE FOR ITS HIGH MORTALITY

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IN A recent study (ANNALS OF SURGERY, vol. lxxix, 1924, p. 538) of 145 cases of acute appendicitis in children (up to and including the twelfth year), it was found that the disease occurred in the first five years of life in 11.7 per cent. of the cases (17 patients) and that the mortality was 35 per cent. Comparing this with the mortality of the entire series, 7.58 per cent., it is seen to be surprisingly high as six of the eleven deaths of the series were during this half decade. An additional fact brought out by the study was that all the appendices of the children under five years of age had perforated before they were operated upon.

Because of these outstanding facts, it was decided to make a further study of acute appendicitis occurring in the first half decade of life. In a review of all the case histories since the establishment of the Children's Surgical Service at Bellevue Hospital in the autumn of 1916 up to the present (June, 1924), there were found forty-three cases of acute appendicitis in children under five years of age (these include the seventeen cases reported in the previous series).

Acute appendicitis is a comparatively infrequent condition during the first five years of life, seldom occurring before the third year. In our previous series in children it appeared in 11.7 per cent. at this age. Gatch and Durman (ANNALS OF SURGERY, vol. lxxix, 1924, p. 862) had three cases under five years in a series of 262 of all ages, being a percentage of 1.14 and 10 per cent. of their cases in the first decade.

Our youngest patient was twenty months old and we had ten in the third year, nine in the fourth year and twenty-three in the fifth year. One case as early as the first month of life and several in the first year have been reported in literature.

The preponderance of the incidence of the disease in the male over the female is similar to that found in later life; there were twenty-seven cases in the former and sixteen in the latter.

The mortality of these forty-three cases was 25.6 per cent., there being eleven deaths. This is high when compared with the mortality of acute appendicitis of childhood or of a series of all ages. In our series of childhood the mortality was 7.58 per cent. and Bancroft (J.A.M.A., 1920, vol. lxxv, p. 1635) reported a mortality of 10.9 per cent. for the first decade. The mortality for a series of all ages varies from 6 per cent. to 9 per cent. (It may be noted that in this larger number of cases the mortality of the first half decade was 25.6 per cent. instead of 35 per cent. as in the seventeen cases of the former series.)

The mortality rate was about the same in the two sexes, though in later life it is relatively higher in the female than in the male. The mortality rate was higher the younger the individual, in the second year 100 per cent., in the third year 60 per cent., in the fourth year 22.2 per cent., and in the fifth year 8.6 per cent.

At operation it was found that in three of the patients the appendix had not perforated. These were all operated upon within twenty-four hours of the onset of the disease and there were no deaths among them. There were seventeen which had localized abscess and were operated upon on an average of four days after the appearance of the first symptoms. In this group there was one death from a status lymphaticus which was confirmed by autopsy. Of the twenty-three remaining cases with diffuse peritonitis, the time lapsing before operation was three days and there were ten deaths (43.5 per cent.). The facts to be brought out are that perforation of the appendix takes place relatively earlier in infants than in older patients, that a spreading peritonitis is the most frequent result of the perforation and that the high mortality of acute appendicitis in infancy is due to the complication of a spreading peritonitis, to which the resistance of the infant is less than the older child, the mortality of the former being 43.5 per cent. and of the latter 18.2 per cent. Spreading peritonitis was accountable for ten of the eleven deaths.

TABLE I
*Showing the Greater Frequency of Perforation with Spreading
Peritonitis in Infancy Producing the Higher Mortality*

	Unperforated		Abscess		Spreading Peritonitis	
	Per cent. of cases	Deaths	Per cent. of cases	Deaths	Per cent. of cases	Deaths
Series of children up to 13 years	33.1	0	36.4	5.7%	30.4	18.2%
Series of children in first half decade	6.9	0	39.5	5.9%	53.5	43.5%

Another fact brought out from a study of the cases is that the younger the individual, the more apt is he or she to develop spreading peritonitis, while as age advances the peritoneum appears to develop the power of walling off infection. This is apparent in the following table, where it is seen that the percentage of cases with abscess, for a given age, is highest in the fifth year, while the percentage of those with spreading peritonitis is lowest. (Table II.)

In twenty-three records the fact was mentioned that a cathartic had been given the child previous to admission. At times the dose, which was usually castor oil, was repeated. None of the unperforated cases received the purge; nine of those with abscess and fourteen of those with spreading peritonitis were purged. At times the child relieved itself of the medicine by immediately vomiting. Of the ten patients with spreading peritonitis who died, it is stated that six received castor oil and two of the remaining had frequent enemas.

In only a few instances did the records mention the fact that a physician had been called in before the patient was admitted. Usually when one had

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been consulted the child was sent to the hospital, but in four records it was mentioned that the patient had seen a doctor at least twenty-four hours before admission and he had prescribed a cathartic.

TABLE II

Age	No. of cases in series	Spreading peritonitis				Abscess				Unperforated		
		No. of cases	Per cent.	Deaths		No. of cases	Per cent.	Deaths		No. of cases	Per cent.	Death
				No. of cases	Per cent.			No. of cases	Per cent.			
Second year . . .	1	1	100	1	100	0	0	0	0	0	0	No deaths
Third year	10	6	60	6	100	3	30	0	0	1	10	
Fourth year . . .	9	6	66	1	16.6	3	33.33	1	33.33	0	0	
Fifth year	23	10	43	2	20	11	47.8	0	0	2	8.7	

To reduce the death rate it is necessary to make an early diagnosis, to prevent perforation if possible, and if perforation takes place, to help the peritoneum localize the infection.

Diagnosis of acute abdominal conditions during early childhood is difficult as we have not the coöperation of the patient, and the early symptoms are so similar to those of the more common gastro-intestinal and respiratory diseases and pyelitis. Acute appendicitis is usually ushered in with vomiting. This occurred in thirty-six of our forty-three cases. In four histories it was stated that the patient had not vomited and in the three remaining no mention of vomiting was made. The child becomes prostrated and apathetic, lies quietly on its back in bed with its legs slightly drawn up. A child with peritoneal inflammation will not sit up. The appearances are that the child is suffering severe pain, but it is usually impossible to obtain definite knowledge of its character and location. The bowels are commonly constipated but occasionally there may be diarrhoea. In the examination a careful inspection is of the greatest importance; the position of the child in bed should be observed and it should be particularly noted whether the respiration is of the abdominal or thoracic type. Abdominal respiration is almost always absent when there is peritoneal inflammation. The symptoms of rigidity and tenderness are difficult to interpret. The abdomen is usually distended and attempts at examination cause the child to resist. It is well to make the examination before the patient is upset. The hand should be gently placed upon the abdomen and in a few moments, when the child has become accustomed to its presence, gentle, firm pressure can be made to elicit muscle spasm. If the child cries and cannot be quieted, the amount of spasm present can be observed during the act of inspiration. At times rigidity of the abdominal muscles is entirely absent, although a spreading peritonitis is present.

The presence of, locality and amount of tenderness is very difficult to determine. In the rectal examination, however, which should never be omitted, the location of the tenderness can frequently be demonstrated.

Intra-abdominal masses can at times be found, though often the mass may prove to be impacted fæces. Here again the rectal examination is of the greatest help.

A rise in body temperature is usually present, though at times the temperature registers normal. A temperature over 102.5 is seldom found. The pulse as well as the respiratory rate is usually up.

The white blood and differential counts are of importance to help confirm the diagnosis, but from a prognostic point of view are of little use. It is needless to state that operation should be performed as soon as a diagnosis is made.

To Summarize.—Acute appendicitis in infancy is a comparatively rare condition and seldom seen before the second year of life. But the mortality is relatively much higher than in later life. The relatively high death rate is due to the higher percentage of rapid perforations followed by spreading peritonitis. The younger the infant the greater is the chance of its developing spreading peritonitis and the less chance has its peritoneum of localizing infection. Cathartics undoubtedly precipitate perforation in many cases. Delay in operative interference is due to tardiness of the parents in consulting medical aid and the difficulty of making a diagnosis when a physician sees the patient at the onset.

THE CLINICAL SIGNIFICANCE OF THE RELATION OF TOTAL AND DIFFERENTIAL LEUCOCYTE COUNTS IN ACUTE APPENDICITIS

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I. INTRODUCTION.—We wish to present in some detail the relationship between the total leucocyte count and the percentage of polymorphonuclear leucocytes in 309 cases of acute appendicitis, with special reference to the effect upon this relationship of sex, age, temperature, pathological process, and infecting organism.

The cases of appendicitis summarized and analyzed in this paper are from the First (Cornell) Surgical Division of New York Hospital, during the last three years. The operations were performed by Dr. Charles L. Gibson, Chief, Dr. Burton J. Lee, Dr. James M. Hitzrot, and Dr. Charles E. Farr. We wish to express our indebtedness to Doctor Gibson for his kindly criticisms and suggestions throughout this work, as well as his permission to use these cases from his service.

II. PREVIOUS WORK.—I. *Leucocytosis*. The blood picture has been used clinically in surgical conditions as a very important point in the diagnosis, as an indication for operation, and in prognosis, for many years. Cabot,¹ in 1894, in a series of cases, noted leucocytosis in every case in which pus was present except two. Sadler,² two years previously, claimed that leucocytosis was generally, though not invariably, present in conditions attended with an exudate of any kind, except tuberculosis. Greenough³ believed a count of 20,000 or more on the first or second day suggested general peritonitis. Coste⁴ held that a count of over 22,000 was indicative of an abscess; Curshmann⁵ believed a count of 25,000 or more suspicious of pus, while Stadler⁶ also believed this figure indicative of pus. French⁷ placed the low figure at 35,000. There is a noticeable scarcity of mention of the differential count among workers before 1905.

The use of the total leucocyte count as an indication for operation was widely used, with little reference to the differential count. Bloodgood⁸ believed a leucocytosis of 18,000 or more within the first forty-eight hours should be considered an indication for operation, specially with an increasing count. Joy and Wright⁹ believed a high stationary or an increasing count indicates a morbid condition of increasing severity which demands operation no matter what the clinical symptoms may be. Aldous¹⁰ believes a count of from 15–30,000 demands immediate operative attention in doubtful cases. And on the other hand, these writers interpret the falling count as an abating

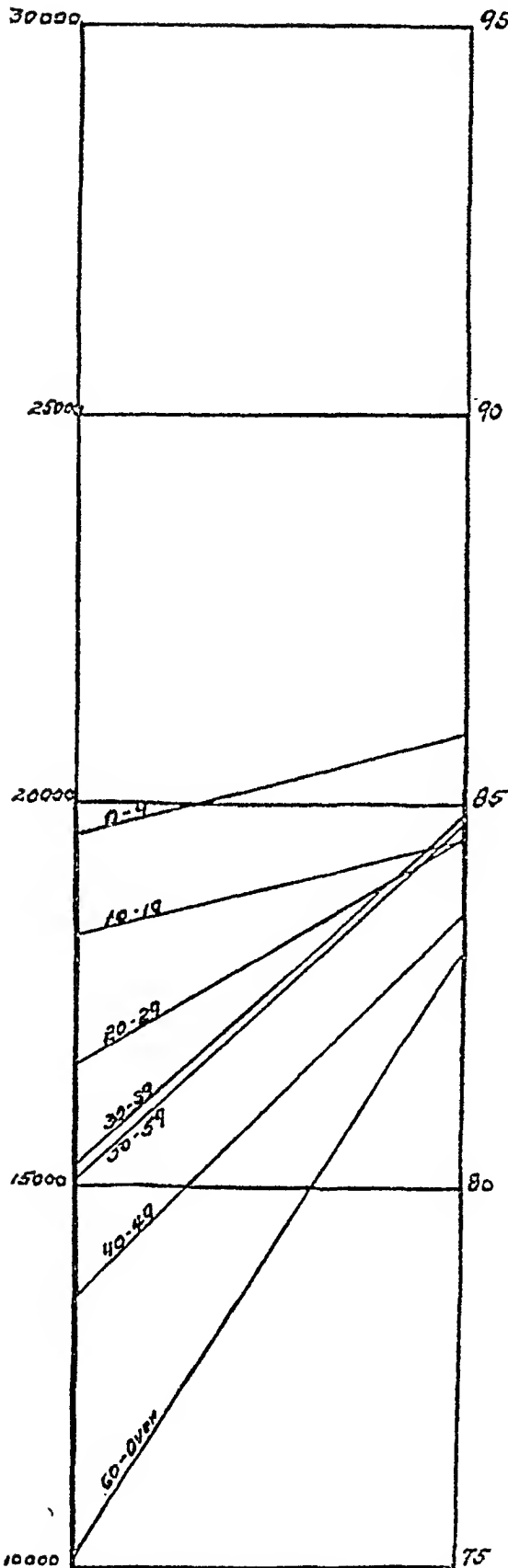


FIG. 1.—Age groups. Resistance line in 309 cases of acute appendicitis.

95% sign. Somewhat similar views were held by Kühn,¹¹ Locke and Cabot,¹² and Curschmann.⁵ DaCosta,¹³ in 1905, summed up the more conservative opinion in a rather widely quoted statement: "The surgeon who attempts to use the blood count in appendicitis as a definite pathognomonic sign will soon run afoul of diagnostic disasters, but he who regards it only as a symptom invariably to be correlated with equally if not more important clinical manifestations, cannot fail to find this method of inquiry of signal value in routine clinical surgery." And a similar view is expressed by Longridge,¹⁴ Cabot,¹⁵ Richardson,¹⁶ French,⁷ Gerngoss,¹⁷ Federmann,¹⁸ and Stadler.⁶ The fallacy of deciding on an operation from the blood count alone was early pointed out. Ewing¹⁰ quotes one of Cabot's cases with 33,000 leucocytes which recovered without interference.

2. *Polymorphonuclear Percentage*.—In 1901, Wilson²⁰ noted the importance of the differential count, stating that 80-85 per cent. polymorphonuclear cells without an increase in total white blood cells was suspiciously high, and over 90 per cent. was still more indicative of a process, usually suggestive of pus. However it was Sondern²¹ who first put forth the rather revolutionary idea that the degree of leucocytosis indicates the amount of body resistance and the degree of polynucleosis indicates the severity of the inflammatory process, while the most important point both in the diagnosis and prognosis is

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the relationship between these two. Sondern's ideas were applied clinically by Gibson²² on a series of cases, with the conclusion that "the differential blood count and its relation to the total leucocytosis is to-day the most valuable diagnostic and prognostic aid in acute surgical diseases that is furnished by any method of blood examination."

3. *Leucocyte Charts*.—In his application of Sondern's principles Gibson²² devised a "standard chart," on which he could portray the relationship of leucocytosis and polymucleosis. He takes as the normal extreme white count 10,000 and the normal extreme polymorphonuclear percentage as 75. The total white count is charted on the left side of the chart and the percentage of polymorphonuclears on the right side, with a rise of one per cent. in polymorphonuclears with each increase in the total white count of 1000 cells. Hence 10,000 is connected with 75 per cent. by a horizontal line, 15,000 with 80 per cent., 20,000 with 85 per cent., etc. With a proportional increase in these two factors, a horizontal line results; with a low total white count and a high percentage of polymorphonuclears, a rising line; and with a high total count and low percentage of polymorphonuclears, a falling line. Hence applying Sondern's principle, a rising line means a relatively poorer body resistance with a more severe inflammatory condition, and hence a more guarded prognosis. And conversely a falling line portrays a proportional good resistance with a less severe infection, and so a better prognosis.

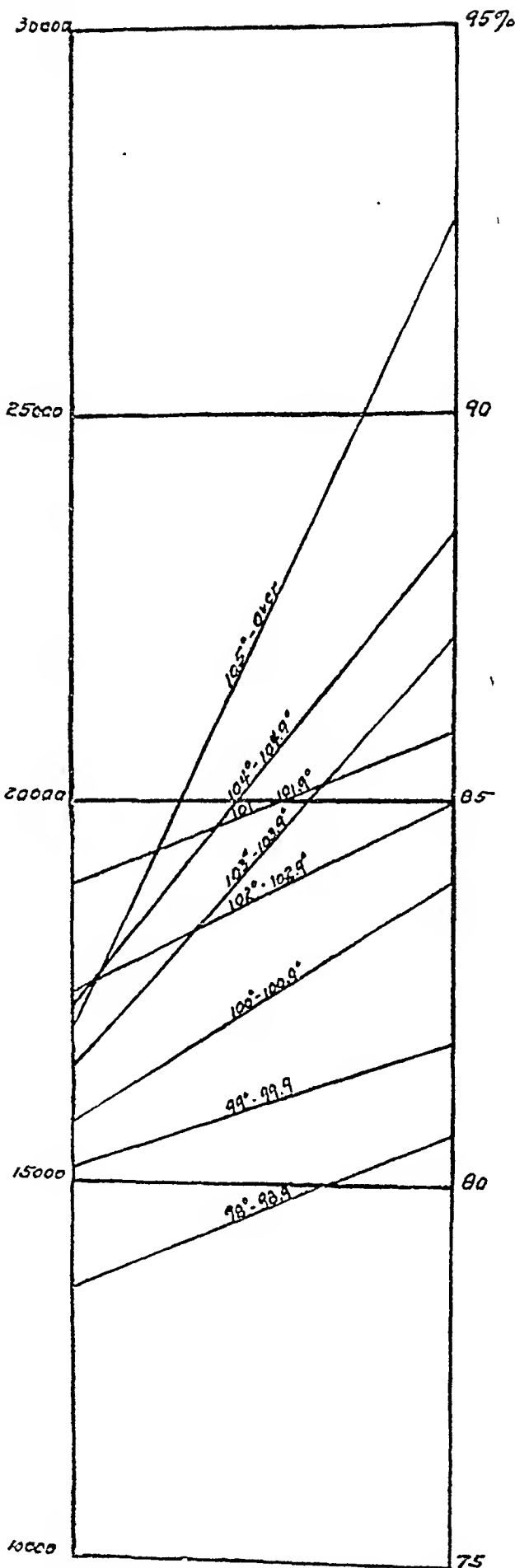


FIG. 2.—Temperature group. Resistance line in 309 cases of acute appendicitis.

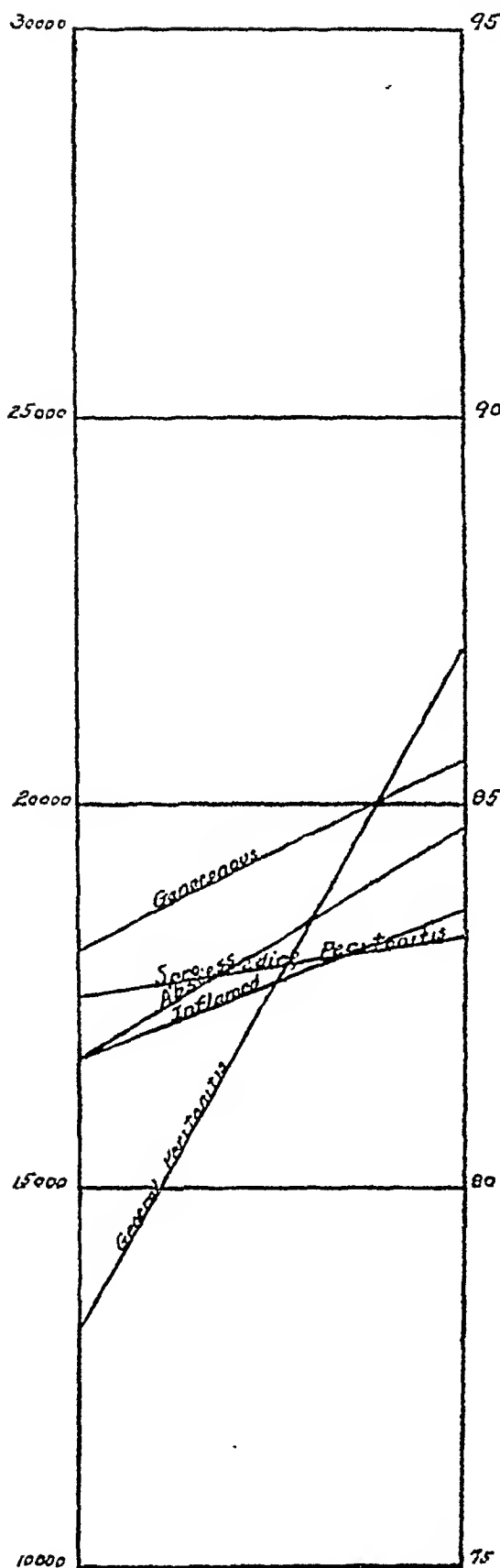


FIG. 3.—Pathological groups. Resistance line in 309 cases of acute appendicitis.

Following Gibson, several writers have proposed methods of graphically expressing this relationship. Wilson,²³ in 1908, and Lampe,²⁴ in 1911, used a modified chart on which they could chart the daily total leucocyte count and the percentage of polymorphonuclears separately, using the same standards of normal as Gibson, and on a given day the two lines to be connected by a third line—the “resistance line.” Coons and Bratton²⁵ suggested a chart on Gibson’s plan, beginning with the same normals of 10,000 and 75 per cent., but mathematically figured out on the principle that the polymorphonuclears are affected in acute septic processes and that other cells remain approximately normal throughout if resistance is good. Hence, if with a total white count of 10,000, 75 per cent. are polymorphonuclears, then with 20,000 leucocytes, 87.5 per cent. would be polymorphonuclears; with 30,000, 91.6 per cent. would be polymorphonuclears, etc. Watters²⁶ has suggested a modified Wilson chart which charts separately the neutrophile percentage and the total leucocyte count in the same vertical plane, and the patient’s condition is judged by the relation of these lines to each other. The most recent attempt to picture this relationship graphically has been made by Walker,²⁷ who by a simple formula figures out the disproportion as it would be shown on Gibson’s chart, and then charts this disproportion figure from day to day.

The present writers have used in the analysis of this series the original Gibson chart, realizing that

while it has faults, they are perhaps less than any of the others. We believe Walker's index to be very valuable, but in a large active service where often only one pre-operative and perhaps one or two or even no post-operative blood counts are made, it is not as useful as that suggested by Gibson.

4. *Leucocyte-polymorphonuclear Relationship*.—Sondern's ideas and Gibson's first clinical results have been verified by many workers and especially as applied to appendicitis. Wilson²⁰ and Fowler,²⁸ in 1908, were among the earliest to confirm the original findings. They agree that the degree of leucocytosis alone is too variable to rely upon; the percentage of polymorphonuclears is a very important signal, but the most helpful diagnostic and prognostic point is the relationship of these two. This view is held also by Coons and Bratton,²⁵ Lampe,²⁴ Watters,²⁶ and more recently by Hewitt,²⁰ Walker,²⁷ Greeley,³⁰ and Rice.³¹ Gibson³² again in 1919 verified his former findings; the results are given below. Contrasted to this view, Noehren³³ and Pease³⁴ and more recently, Jones and Brown,³⁵ believe the percentage of polymorphonuclears the most valuable sign. The former two workers hold that the number of exceptions to the relative disproportion is so great, that its practical value in determining immediate operation is very small. Jones and Brown hold it as reliable prognostic guide. Gibson's³² summary for 705 cases of appendicitis appeared in Trans. Int. Surg. Cong., Paris, 1920. The data of this remarkably large series follow:

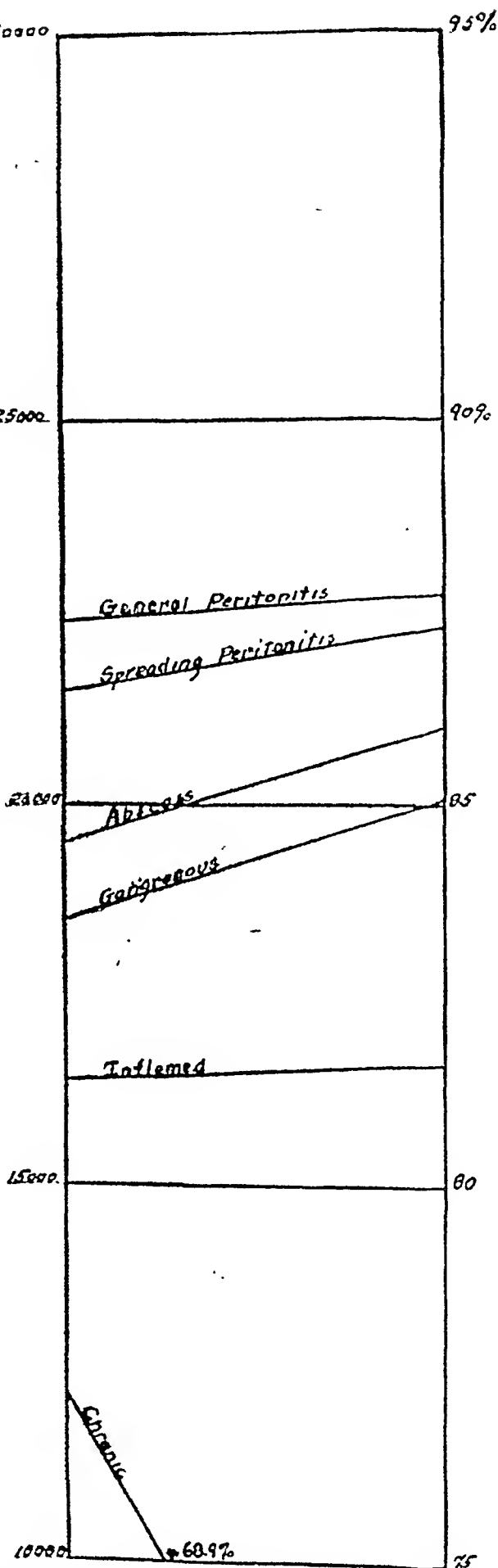


FIG. 4.—Literature cases. Pathological groups of 1945 cases of acute appendicitis.

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	Total cases 705 cases	Recovered 675 cases	Died 30 cases
Average leucocytosis	18,000	18,000	18,000
Average polymorphonuclears	84%	84%	86%
Average disproportion	Plus 1	Plus 1	Plus 3
Recovered—675 cases			
	Average leucocytosis	Average polymorphonuclears	Average disproportion
Male (438 cases)	18,000	84%	Plus 1
Female (237 cases)	18,000	83%	Horizontal
Age:			
Over twenty (384 cases) ...	17,000	83%	Plus 1
Under twenty (291 cases) ..	19,000	84%	Horizontal
Time:			
More than 3 wks. in hospital (158 cases)	20,000	84%	Minus 1
Temperature—102° or more (287 cases)	18,000	82%	Minus 1
Condition of appendix:			
Distended, etc., with no per- foration (360 cases)	17,000	82%	Horizontal
Gangrenous, perforated, etc. (126 cases)	19,000	86%	Plus 2
Localized peritonitis or abscess (156 cases)	20,000	84%	Minus 1
General peritonitis (33)	19,000	85%	Plus 1
Drainage:			
Closed (288 cases)	16,000	82%	Plus 1
Small (98)	18,000	84%	Plus 1
Large (289)	20,000	85%	Horizontal
Died—30 cases			
	Average leucocytosis	Average polymorphonuclears	Average disproportion
Male (16 cases)	18,000	87%	Plus 4
Female (14 cases)	18,000	85%	Plus 2
Age:			
Over twenty (19 cases)	19,000	89%	Plus 5
Under twenty (11 cases)	17,000	81%	Minus 1
Time:			
More than three weeks in hos- pital (3 cases)	23,000	86%	Minus 2
Temperature—102° or more (18 cases)	19,000	88%	Plus 4
Condition of appendix:			
Distended, not perforated (1 case)	23,000	93%	Plus 5
Gangrenous, perforated, (7 cases)	16,000	86%	Plus 5
Localized peritonitis or abscess (11 cases)	18,000	85%	Plus 2
General peritonitis (11 cases).	19,000	86%	Plus 2
Drainage:			
Closed (none)			
Small (1 case)	23,000	93%	Plus 5
Large (29 cases)	18,000	86%	Plus 3

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III. THE PRESENT WORK.—*Jaona*

All data in this series was taken directly from the case histories. The blood counts were made, as a rule, by the junior interne on the service. Care was used to select only cases which had been in good health previous to the attack of appendicitis.

In the analysis of our series, as well as the literature, we constantly refer to the term disproportion, expressing it in a minus or plus figure. We refer to the disproportion between the leucocytosis and the polynucleosis. We have followed Gibson's example, using 1000 cells as a unit. When there are 10,000 leucocytes with 75 per cent. polymorphonuclears, there is a normal proportion or no disproportion, and these two figures are connected on the chart by a horizontal line. On the other hand, with 11,000 leucocytes and 75 per cent. polymorphonuclears, there is a disproportion of minus one, and a falling line connects the two figures. With 10,000 leucocytes, and 76 per cent. polymorphonuclears (the normal proportion for 11,000 white cells), there is a disproportion of a plus one, with a rising line. For the sake of accuracy in this work, we have analyzed our cases to 0.1 of a unit, although we realize this is probably not practical in routine work for individual cases, nor is it necessary.

1. *Sex and the Resistance Line.*—It is of interest to note in passing that 62 per cent. of our series of 209 acute cases were males. Maylord⁸⁶ found 51 per cent. males in 1000 cases; Deaver and Ravdin,⁸⁷ 52 per cent. in 500

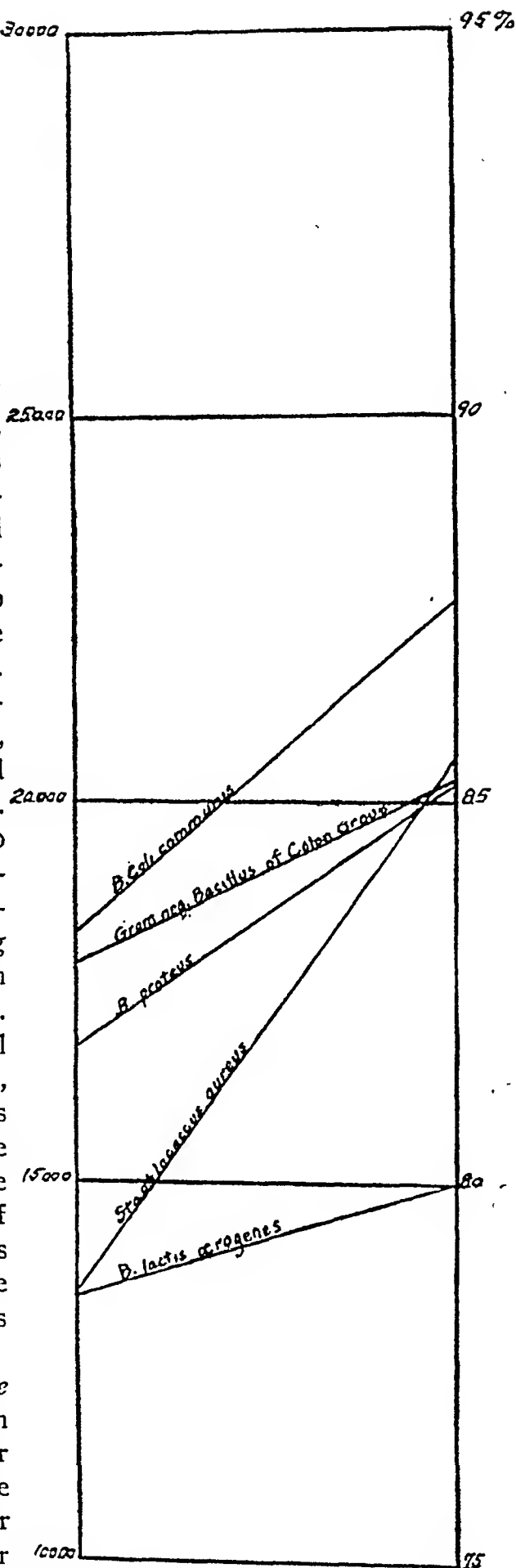


FIG. 5.—Infecting organism. Resistance line in 64 cases of acute appendicitis.

cases; Gibson,³² 65 per cent. in 705 cases; Sonnenburg,³⁸ 67 per cent. in 1000 cases; Roux,³⁸ 53 per cent. in 670 cases; Barbier,³⁸ 76 per cent. in 616 cases; LaRoque³⁰ alone reports a predominance of females in 400 cases. In our series, the resistance line for the males is plus 2.5, and for the females plus 2.4. In Gibson's³² series, the males are plus 1, and the females chart a horizontal line. From these figures the females show a slightly better resistance, but we feel that the difference is so slight that it is without significance.

Males	192 cases	W. B. C.	17,407	Polys.	84.9%	Dispro.	plus 2.5
Females	117 cases	W. B. C.	16,378	Polys.	83.7%	Dispro.	plus 2.4

2. *Age and the Resistance Line.*—The general principle that the younger the individual the better his resistance is well illustrated in this series. It will be noted from the table below and Fig. 1, that the most favorable resistance is offered in the first decade, and gradually becomes less favorable with progressing age. The resistance line gradually changes from a slightly rising line (a disproportion of plus 1.3) in the first decade to a steeply rising line in the sixth decade (a disproportion of plus 7.8).

Age	Number of cases	Average W.B.C.	Average Poly. Per cent.	Disproportion
0-9	25	19,604	85.9	Plus 1.3
10-19	113	18,298	84.5	Plus 1.2
20-29	76	16,631	84.5	Plus 2.9
30-39	48	15,303	84.8	Plus 4.5
40-49	29	13,659	83.5	Plus 4.9
50-59	13	15,115	84.7	Plus 4.6
60 and over	5	10,266	83.0	Plus 7.8

In Gibson's³² series of 384 cases over twenty years, there was an average disproportion of plus one, while in 291 cases under twenty, the average disproportion is charted as a horizontal line. Sondern²¹ holds that children gave unreliable counts because their polymorphonuclear percentage is a greater variable quantity. Wilson²³ also noted that more exceptions are found in children. Our series shows quite definitely that the best resistance is offered under twenty years of age, and the resistance becomes progressively less as the age increases.

3. *Temperature and the Resistance Line.*—The temperature used in this analysis was the admitting temperature. The resistance line compares roughly with the temperature in that it changes from a plus 2.1 for temperature between 98° and 99°, to plus 10.5 for cases over 105°. There is a slight variance under 101°, but above this point the disproportion figure steadily rises.

Temperature	Cases	W.B.C.	Polys. Per cent.	Disproportion
98-98.9	15	13,686	80.7	Plus 2.1
99-99.9	42	15,230	81.9	Plus 1.7
100-100.9	73	15,836	84.0	Plus 3.2
101-101.9	84	18,990	85.9	Plus 2.0
102-102.9	60	17,582	85.0	Plus 2.5
103-103.9	20	16,585	87.2	Plus 5.5
104-104.9	13	17,300	88.5	Plus 6.2
105 and over	2	17,000	92.5	Plus 10.5

Greenough³ stated that in a series of cases, the degree of leucocytosis corresponded roughly with the degree of temperature, but individual cases vary greatly, although he gives no data. On the other hand, Mitchell⁴⁰ feels that the relation of the temperature to the leucocytosis does not seem to give reliable information, as cases are seen with grave clinical symptoms and high blood counts with little or no temperature. Gibson³² found in 287 cases which had a temperature of 102° or more, an average white count of 18,000 and 82 per cent. polymorphonuclears, a disproportion of minus 1.0. We find in our series, as can be seen in the above figures, a steadily increasing polymorphonuclear percentage, while the total white count remains approximately stationary after 101°. Attention is called to the rising disproportion figure, shown graphically in Fig. 2.

4. *The Pathological Process and the Resistance Line.*—In an effort to establish a relationship between the pathological process and the blood picture, we have classified our cases in a classification modified from that used by Fowler,²⁸ as follows:

- A. Non-perforated (without pus).
 1. Inflamed.
 2. Gangrenous.
- B. Gangrenous with perforation.
 1. Local peritonitis with abscess, pus limited by its position or adhesions.
 2. Spreading peritonitis, limited to the right lower quadrant, or to the lower abdomen.
 3. Diffuse general peritonitis.

And in a further effort to establish the above-mentioned relationship, we have grouped and analyzed 1945 cases recorded in the literature.

In the analysis of our series, there is a very gradual increasing disproportion (with the exception of the spreading peritonitis group) from plus 1.9 in the simple inflamed cases, to plus 8.8 in the general peritonitis group. This is graphically shown in Fig. 3. The analysis of the thirteen deaths occurring in this series shows a rising line of plus 6.0 (note Fig. 6).

Class	Cases	W.B.C.	Poly. Per cent.	Disproportion
Inflamed	138	16,703	83.6	Plus 1.9
Gangrenous	65	18,100	85.6	Plus 2.4
Abscess	65	16,794	84.7	Plus 3.0
Spreading peritonitis	26	17,584	83.3	Plus 0.8
General peritonitis	15	13,223	87.0	Plus 8.8
Total	309	16,921	84.3	Plus 2.4

We believe these figures, and more graphically the chart (3), show in general, a better resistance and consequently prognosis in the less severe pathological processes, while a more nearly horizontal line or rising line indicates a more severe process.

Detailed analysis of our series may be noted on the table; salient points might be mentioned:

(a) Inflamed group: 138 cases, with an average leucocyte count of 16,703, with extremes in individual cases from 5900 to 42,000; an average

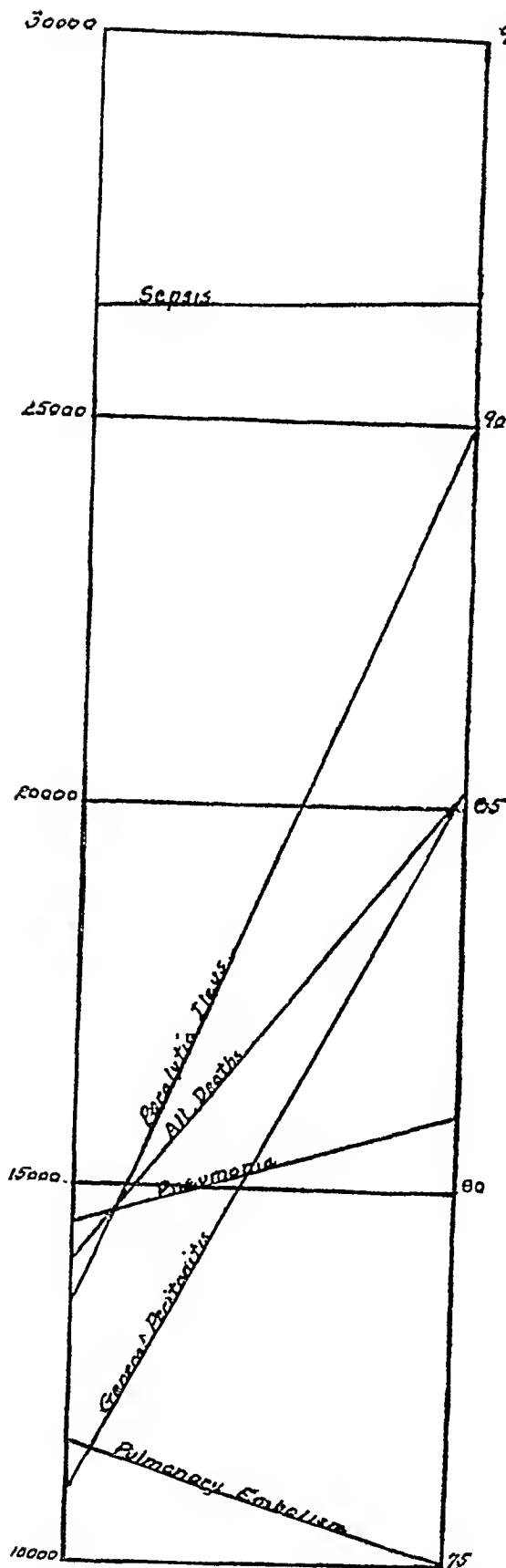


FIG. 6.—Deaths. Resistance line in 13 cases of acute appendicitis.

95% polymorphonuclear percentage of 83.6, with extremes from 50 per cent. to 98 per cent. The average disproportion is plus 1.9.

(b) Gangrenous non-perforated group: 65 cases, with the highest average leucocyte count of any group, 18,100, with extremes in individual cases from 8000 to 40,000; an average polymorphonucleosis of 85.6, extremes from 66 per cent. to 96 per cent. An average disproportion of plus 2.4.

(c) Abscess group: 65 cases, average leucocytosis of 16,794, with individual extremes from 5000 to 30,000, the former being a large localized abscess; an average polymorphonucleosis of 84.7, with extremes from 68 per cent. to 98 per cent.; and a disproportion of plus 3.0.

(d) Spreading peritonitis group: 26 cases, average leucocyte count 17,584, with extremes from 6800 to 35,200; the lowest average polymorphonuclear percentage of any group, 83.3 per cent., with extremes from 68 per cent. to 98 per cent.; and the lowest disproportion of any group—plus 0.8. It is of interest to note that this group, possibly because it is most poorly defined, should present a polymorphonuclear percentage indicative of the least severe process, while pathologically at operation, the process is found more severe, as a rule, than any of the above three groups. We can not offer a satisfactory explanation for this apparent discrepancy. Stahl has emphasized that it is not the presence of pus that modifies the cell count, but the consequences of the presence of

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pus. It would appear that in this condition, the spreading of the process over an increased territory must be less intensified than in the case of a well-developed, though localized abscess.

(c) General peritonitis group: 15 cases, average leucocyte count of 13,223, with extremes from 6500 to 20,000, the lowest average leucocyte count; an average polynucleosis of 87.0 per cent., with extremes from 80 per cent. to 90 per cent., the highest average polymorphonuclear percentage. The disproportion of plus 8.8 is much the highest of any group. Attention is called here to the poor resistance as indicated by the total white count and the severity of the process as indicated by the percentage of polymorphonuclears. Other writers have called attention to this picture, supposing that the rapid spreading of the condition literally overcomes the body's resistance, with this blood picture resulting.

5. *Post-operative Course and the Resistance Line.*—While data were collected on the post-operative course, complications, type and amount of drainage, and post-operative blood counts, we did not establish a definite relationship between the blood findings pre-operative and the post-operative course. We agree with Meleney⁴² that infection and contamination have nothing to do with the initial rise, though they will of course maintain the count above normal.

6. *Lymphocytes and the Resistance Line.*—No special attention has been paid in this series to the total lymphocytes, but the work of Holmes,⁴³ Williams,⁴⁴ Mehrtens,⁴⁵ and recently Jones and Brown,³⁵ indicates the lymphocytes are worthy of consideration. The last named investigators hold the total lymphocyte count as a very reliable index of the patient's state of resistance, and closely parallels Walker's index.

7. *The Infecting Organism and the Resistance Line.*—In those cases where an organism could be cultured directly from the pathological condition found, we have collected the data on these cases. Farr⁴⁶ has recently collected the data on the infecting organisms with reference to the wound healing, and type of organisms. We have found 64 cases in which the organism was definitely cultured.

DIFFERENTIAL COUNT

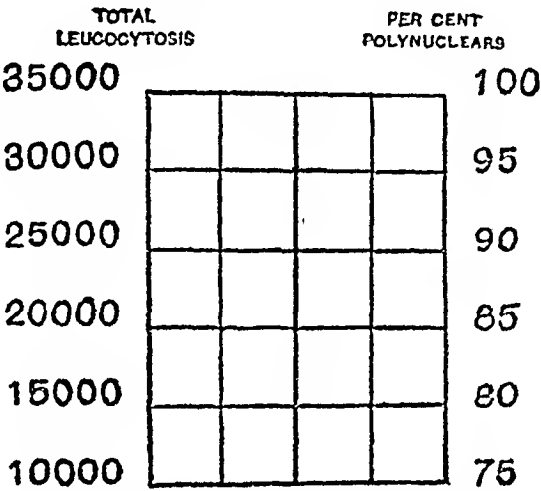


FIG. 7.—Gibson's "Standard Chart." The other charts shown are modifications of this for analytical purposes.

Organism	Cases	W.B.C.	Poly.	Per cent.	Disproportion
B. coli communis	24	18,308		87.6	Plus 4.3
Gram-neg. bacillus of colon group	25	17,920		85.3	Plus 2.4
B. proteus	10	16,860		85.2	Plus 3.4
Staphylococcus aureus	3	13,600		85.6	Plus 7.0
B. lactis aerogenes	2	13,500		80.0	Plus 1.5

Also one case of each of the following: *B. pyocyaneus*, *staphylococcus albus*, *streptococcus haemolyticus*, and a non-haemolytic streptococcus. A large number of cases of mixed infections were also collected, but because of difficulty in an interpretation of such cases, we have omitted them. We feel that not a great deal of significance should be attached to the above findings, since one strain of the same organism may be much more virulent than another strain, and hence be the cause of a more severe reaction. It is interesting to note that

*GENERAL AVERAGES OF LEUCOCYTOSIS AND POLYNUCLEOSIS
OF 1945 CASES OF APPENDICITIS*

Author	Cases		Chronic	Sub-Acute	Inflamed	Gangrenous	Abscess	Perforated	Spreading Peritonitis	General Peritonitis	Total Average
FOWLER (1928)	270	Cases	33	12	59	15	25	—	27	38	—
		Ave W.B.C.	11150	16500	19200	18700	21300	—	25700	32750	—
		Ave % Polys	60.75	73.75	82.0	88.3	83.3	—	88.0	86.3	—
NOEHREN (1928)	69	Cases	—	—	19	11	24	—	4	12	—
		Ave W.B.C.	—	—	12500	18725	16270	—	23125	18330	—
		Ave % Polys	—	—	80.3	86.2	82.0	—	89.7	88.6	—
PEASE (1928)	300	Cases	63	—	27	20	14	—	101	27	300
		Ave W.B.C.	12900	—	14700	19400	22200	—	21000	51800	17043
		Ave % Polys	69.0	—	77.0	85.0	88.0	—	88.0	89.0	83.0
COONS and BRATTON (1927)	184	Cases	—	—	41	22	62	12	27	14	184
		Ave W.B.C.	—	—	16090	15525	18677	24038	20072	24678	19094
		Ave % Polys	—	—	81.9	82.0	82.2	82.1	87.5	92.5	84.6
HEWITT (1927)	100	Cases	—	—	35	—	25	—	20	—	—
		Ave W.B.C.	—	—	16652	—	17517	—	20072	—	—
		Ave % Polys	—	—	81.0	—	87.3	—	89.5	—	—
GIBSON (1922)	705	Cases	—	—	360	126	156	—	—	33	695
		Ave W.B.C.	—	—	17000	18000	20000	—	—	12000	18000
		Ave % Polys	—	—	82.0	86.0	85.0	—	—	85.0	82.0
	30	Cases	—	—	1	7	11	—	—	11	30
		Ave W.B.C.	—	—	23000	11000	18000	—	—	12000	12000
		Ave % Polys	—	—	93.0	86.0	85.0	—	—	86.0	86.0
MENNINGER and HEIM (1922)	309	Cases	—	—	139	65	65	—	26	15	309
		Ave W.B.C.	—	—	16703	18100	16754	—	17524	17023	16921
		Ave % Polys	—	—	83.6	85.6	84.7	—	83.3	87.0	84.3

FIG. 8.—Average leucocyte and polymorphonuclear counts in 1945 cases from the literature.

the Gram-negative bacillus of the colon group is associated with the best resistance and *staphylococcus aureus* with the highest disproportion.

IV. CASES FROM THE LITERATURE.—An attempt has been made by the writers to group the cases in the literature where the investigator has given his data. With the exception of Gibson,³² every writer has classified his cases only on the pathological findings of the appendix at operation. We have included the data given by Fowler²⁸ on 278 cases, Noehren³³ on 69 cases, Pease³⁴ on 300 cases, Coons and Bratton²⁵ on 184 cases, Hewitt²⁰ on 100 cases, Gibson³² on 705 cases, and our own series of 309 cases, a total of 1945 cases. Even in this list complete data have not been given in all cases, and the present writers have taken the liberty to compute the average leucocyte count and the percentage of polymorphonuclears in the cases of Noehren and Coons and Bratton, from the data given by these authors. Because there was some variance in the classification of cases by the various writers, an all-inclusive classification has been used (note Fig. 8), although attention has been paid only to the larger groups—inflamed, gangrenous, abscess, spreading peritonitis, and general peritonitis.

LEUCOCYTE COUNTS IN ACUTE APPENDICITIS

The analysis of the cases in the literature as a group, in general, supports the findings in our own series, in that the relatively poorer resistance is associated with the more severe process. This is graphically shown on Fig. 4. While there is a general increase in both the total leucocyte count and the percentage of polymorphonuclears, the disproportion of plus 0.2 for the inflamed group is raised to plus 0.3 in the general peritonitis group. On closer analysis of the latter group, if the exceptionally high averages of

SUMMARY OF CASES FROM LITERATURE

		ACUTE APPENDICITIS																			
	AUTHOR	Number of CASES	Average WBC	TOTAL LEUCOCYTE COUNT						POLYMORPHONUCLEAR COUNT											
				Under 10000	10000-15000	15000-20000	20000-25000	25000-30000	30000-35000	Avg. Poly	Under 75%	75-80%	80-85%	85-90%	90-95%	95-100%	Disproportion				
INFLAMED	Reese	47	12700	11	15	11	7	1	1	77	17	9	7	11	3	0	-2.7				
	Nashron	18	14500	2	0	7	1	0	0	80.3	4	5	2	5	1	0	+0.9				
	Fowler	30	19200	4	13	14	4	2	1	84	2	6	9	17	7	0	-0.6				
	Coccos & Beattien	41	16000	0	12	16	3	2	2	81.9	3	11	14	12	1	0	+0.1				
	Menninger & Heim	130	16700	10	54	41	19	6	0	83.6	9	13	47	47	20	3	+1.9				
	Gibson	360	17000	—	—	—	—	—	—	82.0	—	—	—	—	—	—	+0.0				
	Henrich	35	16650	—	—	—	—	—	—	81.0	—	—	—	—	—	—	+0.6				
TOTALS		677	16465							81.6							+0.2				
GANGRENOUS	Reese	20	19800	2	6	10	6	3	1	85	5	0	6	11	5	1	+0.6				
	Nashron	11	10700	2	2	3	1	3	0	86.0	0	2	3	2	3	0	+0.5				
	Fowler	15	18700	1	4	5	4	1	0	84.3	1	1	1	6	6	0	+0.6				
	Coccos & Beattien	52	15545	4	6	7	5	0	0	84	0	3	9	10	0	0	+3.5				
	Menninger & Heim	65	18100	1	10	23	10	3	2	85.4	2	6	13	24	10	1	+2.3				
	Gibson	126	19000	—	—	—	—	—	—	86	—	—	—	—	—	—	+2.0				
	Henrich	Included under Abscess																			
TOTALS		267	18510							85.1							+1.6				
ABSCESS	Reese	14	22200	1	3	2	4	2	2	88	0	1	5	5	2	2	+0.0				
	Nashron	29	16270	2	0	3	4	0	0	80.0	4	6	4	6	0	0	-1.2				
	Fowler	95	21300	7	35	16	23	10	4	83.2	7	13	25	24	14	0	-3.0				
	Coccos & Beattien	62	10177	1	10	20	16	4	3	82.2	2	15	20	13	5	0	-1.6				
	Menninger & Heim	65	16784	7	17	20	14	4	2	84.7	2	13	15	14	14	3	+3.0				
	Gibson	151	20000	—	—	—	—	—	—	82.0	—	—	—	—	—	—	-1.0				
	Henrich	45	17517	—	—	—	—	—	—	82.3	—	—	—	—	—	—	+4.0				
TOTALS		460	19544							86							+1.5				
SPREADING PERITONITIS	Reese	101	21100	5	16	29	29	9	13	80	9	10	16	27	31	0	+1.9				
	Nashron	4	23125	0	1	1	1	1	0	89.7	0	0	1	0	1	0	+0.6				
	Fowler	47	25700	2	12	11	8	5	9	88	1	2	11	24	9	0	-2.7				
	Coccos & Beattien	27	20023	0	7	10	3	4	3	87.5	0	1	5	12	9	0	+2.5				
	Menninger & Heim	26	17524	2	6	9	4	3	1	82.3	0	2	9	5	0	2	+0.0				
	Gibson	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—				
	Henrich	Included under General Peritonitis																			
TOTALS		205	21521							82.8							+0.0				
GENERAL PERITONITIS	Reese	47	21800	4	11	10	0	3	11	89	4	4	4	19	13	3	+2.2				
	Nashron	12	18330	0	5	3	2	2	0	89.4	0	1	2	6	3	0	+5.3				
	Fowler	30	32770	1	12	9	5	7	4	86.2	0	3	3	17	15	0	+0.7				
	Coccos & Beattien	14	28678	1	0	3	1	6	3	92.5	0	0	0	3	7	4	+2.9				
	Gibson	44	19000	—	—	—	—	—	—	85.4	—	—	—	—	—	—	+1.0				
	Menninger & Heim	15	13228	3	0	3	1	0	0	87.0	0	0	4	6	3	0	+0.0				
	Henrich	20	20072	—	—	—	—	—	—	87.5	—	—	—	—	—	—	+4.5				
TOTALS		290	27480							87.7							+0.2				
CHRONIC APPENDICITIS																					
CHRONIC	Reese	43	12900	20	27	11	1	3	0	89.0	41	11	2	1	0	0	-0.9				
	Fowler	33	11150	18	0	6	0	0	0	87.7	19	5	5	1	0	0	-7.3				
TOTALS		46	12250							88.3							-4.3				

FIG. 9.—Summary of total leucocyte and polymorphonuclear counts in cases from the literature.

Fowler are omitted, the remaining 152 cases show a disproportion of plus 3.1. The findings of Fowler in the cases of spreading peritonitis and general peritonitis are much higher general averages than found by any other worker reported, while the average leucocytosis in general peritonitis noted by the present writers is much lower than noted by any other workers.

Pathological group	Number of cases	Average W.B.C.	Average poly. Per cent.	Disproportion
Chronic	96	12,298	68.9	Minus 8.3
Inflamed	677	16,465	81.6	Plus 0.2
Gangrenous	267	18,510	85.1	Plus 1.6
Abscess	461	19,594	86.0	Plus 1.5
Spreading peritonitis ...	205	21,520	87.3	Plus 0.8
General peritonitis	190	22,480	87.7	Plus 0.3
If the exceptionally high figures of Fowler are omitted from the last two groups, the averages are much changed:				
Spreading peritonitis ...	158	20,270	87.0	Plus 1.8
General peritonitis	152	19,980	88.0	Plus 3.1

V. SUMMARY.—1. Sex: Sixty-two per cent. of our series of 209 cases of acute appendicitis were males; the females showed a resistance of plus 2.4 and the males plus 2.5; Gibson's series parallels these figures.

2. Age: There is a steadily rising disproportion from the first decade to the sixth decade, from plus 1.3 to plus 7.8; so that the resistance line changes from a slightly rising line to a steeply rising line.

3. Temperature: The disproportion index varies to a slight degree under 101° , but from this point steadily increases with the temperature to a plus 10.5 at or over 105° .

4. Pathological process: A general classification for the process found at operation has been used, and cases classified as inflamed, gangrenous, abscess, spreading peritonitis, and general peritonitis. The general trend of the resistance line is to change from a slightly rising line (plus 1.9) in inflamed cases to a very steeply rising line (plus 8.8) in general peritonitis cases. The one exception is the series of spreading peritonitis which shows the most nearly horizontal line.

5. Post-operative course: No definite relationship was established between the course post-operative and the pre-operative blood picture.

6. Lymphocytes: No attempt was made to study the lymphocyte count, though attention has been called to its value by other workers.

7. Infective organism: Data presented on 64 cases where the infecting organism was cultured, show the staphylococcus aureus associated with the highest disproportion (plus 7.0).

8. Literature cases: 1945 cases have been grouped and analyzed on the pathological findings at operation. We find a gradual rise in the disproportion from minus 8.3 for the chronic cases to plus 0.3 for the general peritonitis cases. With the omission of one worker's figures, the results given by six other workers show a disproportion for the general peritonitis of plus 3.1.

VI. CONCLUSIONS.—1. SEX: Females show a slightly better resistance than males, but the difference is so slight, that we do not give it weight.

2. Age: The younger the patient, the better is his resistance. This fact, which is generally regarded as an axiom, is here supported by actual findings, and has been found to hold for all ages.

3. Temperature: The temperature, as shown in a series of cases, is proportional to the polynucleosis and to the resistance index, although it shows slight variation under 101° .

4. Pathological process: The best resistance is offered by the individual against the less severe pathological process. With an extensive process, the body resistance is overwhelmed.

5. Infective organism: The type of organism very probably plays a rôle in the severity of the inflammatory process and consequently in the resistance index, but because of varying degrees of virulence of different strains of the same organism, definite conclusions can not be drawn from the data here presented.

6. We support the principles that the total leucocyte count is a measure of body resistance against an inflammatory process up to a certain degree of leucocytosis; the percentage of polymorphonuclears is an index of the severity of the inflammatory process; and that the greatest aid to be obtained from a pre-operative blood count as to indication for operation, is the relationship of these two, as described in this article.

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LATE RECURRENCE AFTER RADICAL OPERATION FOR CARCINOMA OF THE BREAST*

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IN JUNE, 1921, three patients on whom I had done a radical operation for carcinoma of the breast 12 to 16 years previously, came to me on account of the recurrence of the growth, or the fear of it. A few months later I saw in consultation and operated for recurrence a patient who had had a carcinoma of the breast removed 11 years before at St. Vincent's Hospital.

Two of these, presenting themselves 12 and 11 years after the primary operation, had local recurrence. The latter case had also a carcinoma of the opposite breast. One patient had carcinoma of the opposite breast without recurrence in the breast operated on 16 years before. The fourth patient, also operated 16 years before, had no recurrence and no tumor of the other breast, but came to the hospital because of symptoms suggesting a possible abdominal metastasis. Thorough examination, including X-ray, gave no evidence of such a growth, her symptoms cleared up and she was discharged from the hospital. In these patients 11 to 16 years had passed between the primary and secondary operations, hence the time after operation when we can call a patient cured is indefinitely prolonged.

Recurrence, after radical operation for carcinoma of the breast, is the rule and not the exception. The statistics of seven German Clinics, quoted by Ransohoff,¹ showed that 58 per cent. of the cases operated recurred locally, or in the axillary or supraclavicular glands. Of these 22 per cent. occurred after the third year.

The statistics of the results after operation for carcinoma of the breast vary to some extent, according to the percentage of all cases that are heard from, the proportion of gland-free cases and the operator's willingness to operate on advanced cases. They have improved in recent years, but not as much as one would expect, with the improvement of the technic and the use of the X-ray, because more of the advanced cases, in which recurrence is more frequent, are operated on.

Among cases operated by a number of British surgeons, G. P. Mills² found a six-year cure in 39.8 per cent. of all cases and 62.9 per cent. of gland-free cases.

Sistrunk³ found 36.7 per cent. of all cases alive † five to eight years after operation and 64 per cent. of gland-free cases. This shows that Sistrunk's series contained more gland-infected cases, and exemplifies the inaccuracy of comparing statistics.

* Read before the New York Surgical Society, October 22, 1924.

† Nine had recurrence.

The duration and stage of the growth, the presence of lymphatic involvement, the type of cancer, and the age of the patient influence the ultimate result more than any other factors. Of these the duration of the growth is the most important, for, as Bloodgood⁴ says, "If the lump felt by the patient proves to be cancer, its duration is the only controllable factor in the ultimate cure." Also, "The percentage of the recurrences after five years gradually rises with each two-month period of time," between the origin of the growth and the operation.

The type of the radical operation that is employed is of comparatively minor importance, provided the lymph-bearing fascia is thoroughly removed. Of those who lived three years or more after operation at the Massachusetts General Hospital, Greenough, Simmons and Barney⁵ found that 19 per cent. developed recurrence. This is the same percentage found by Schroeder in the Rostock Clinic. Halsted⁶ found that 20 per cent. of those living over five years after operation had recurrence later on. Among the seventeen recurrences after the third year at the Rostock Clinic, 47 per cent. developed after the fifth year.

A brief history of my patients with late recurrence brings up some interesting questions as to the nature of recurrence and its treatment.

CASE I.—Mrs. L. E. W., forty-two years, was operated by me at the Presbyterian Hospital for an adenocarcinoma of the right breast in April, 1909. A lump had first been noticed in the breast two months before. The axillary glands were not involved. She was well for twelve years, until April, 1921, when she noticed a small hard lump in the lower part of the scar, which grew slowly until it was the size of a marble. It was hard and nodular and extended to the inner side of the scar. No lymph glands were palpable. It was removed, under local anæsthesia, June 27, 1921, and the specimen was examined by Dr. James Ewing and pronounced carcinoma. She was referred to the Memorial Hospital for treatment by radiation and from their records I abstract the following. In July, 1921, there was no evidence of any disease and no X-ray evidence of metastases in the chest.

On August 6, 1921 a hard area, 4 by 2 cm., was noted in the right infraclavicular region, which, she said, had been present since operation. Radium pack treatment of the right chest area four times, from August 10 to October 13, 1921, and again on March 19, 1922. On January 16, 1922 a growth was noted in the scar over the fifth rib. Six weeks later this measured about 1 cm. in diameter. In September, 1922, this was noted by the visiting nurse as a small hard tumor in the scar. She did not return to the hospital, the nodule finally ulcerated so that in September and October, 1923 discharge and bleeding were noted. At the latter date she was very weak and died November 3, 1923, about two years and eight months after the appearance of the recurrence. Her death was accelerated by three severe hemorrhages from the vagina, due to sloughing after the use of radium in the cervix, though no new growth was found under anæsthesia. She was greatly weakened and never fully recovered from these hemorrhages. In this case radium did not have a good effect on the breast and a very poor one on the cervix.

CASE II.—Mrs. P. F., fifty-five years old, was seen in consultation March 31, 1922, Eleven years before her right breast had been removed for carcinoma by a radical operation at St. Vincent's Hospital. For about two years she had noticed small hard nodules under the skin and the scar of the right breast. These have slowly increased in size and two or three have ulcerated. About a year ago a tumor developed in the left breast, the nipple became retracted and the lump slowly increased. On examination this is hard, nodular and movable on the parts beneath. The left axillary nodes are moderately

enlarged. No supraclavicular glands are palpable. There is an ulceration, 2 by 3 cm., in or near the scar of the right breast and several small hard nodules around this.

On April 14, 1922, I did a radical operation on the left breast and axilla, with Stewart's incision. She was referred to Memorial Hospital for X-ray and radium treatment. Twelve treatments by X-ray and one by radium were given from July 22, to October 23, 1922. In November, 1922 there was no evidence of disease, except three small areas, scabbed over, but an X-ray plate shows evidence of metastases in the chest.

In April, 1923, several small nodules in the skin of the right chest, which had been treated by the insertion of bare radium tubes, had disappeared, leaving one or two small ulcers. No other evidence of local recurrence.

In June, 1923, a node, 2 by 2 cm., was noticed in the right supraclavicular region, which was rayed. Again in September, 1923 one or two small recurrent nodules were noticed in the scar of the right breast. About the end of October, 1923, dullness and diminished breathing were noted in the lower part of the right chest and enlarged glands were felt in the right axilla. She was evidently not doing well and three days later two quarts of a blood-tinged fluid were aspirated from the right chest. An X-ray plate, taken a day or two later, showed thickened pleura, peribronchial infiltration and fluid at the right base. She died in November, 1923.

CASE III.—Mrs. K. C., fifty-eight years, entered Bellevue Hospital, June 13, 1921. Following a radical operation for carcinoma of the right breast, which I did in Bellevue sixteen years before, she had had no trouble until three weeks before when she noticed bleeding from the left nipple, without any change in the size or consistency of the breast. One miscarriage twenty years ago, no children, menopause nine years ago. On examination there was a hard indurated mass, the size of a quarter of a dollar, around and including the left nipple. The surface was ulcerated, with a sloughy base. The nodule was movable. No nodes were palpable in the axilla.

After operation by another surgeon on the second surgical division, she developed infection of the wound and an abscess was opened and drained. Her resistance was poor, she became septic and died, a little over a month after operation. Microscopic examination showed adenocarcinoma. Axillary nodes showed no involvement.

CASE IV.—Mrs. M. R., sixty-three years old, entered Bellevue Hospital, June 8, 1921. She showed the scar of a radical operation for carcinoma of the breast, which I had done at the Presbyterian Hospital, sixteen years before. Since then she had had a pelvic operation and a cholecystectomy, respectively six and five years ago. Though she complained of abdominal pain, gas, vomiting, loss of appetite and headache, an X-ray examination was negative, the symptoms cleared up under treatment and the suspicions of an abdominal metastasis were not confirmed.

We may consider the questions raised by the cases reported above, and other similar cases, as they relate to (1) local and regional recurrence and (2) the development of cancer in the other breast.

(1) One striking feature of the two cases of local recurrence reported was the persistence or virulence of the recurrence, when once established. Another, and perhaps a more correct, way of describing it is that the patient showed a lowered resistance. Is this lowered resistance a general process, a diminution of cellular differentiation and hyalinization, which MacCarty⁷ thinks promotes post-operative longevity, or is it due to a local weakening or absorption of the encapsulation of the tumor cells?

At a meeting of the American Surgical Association in 1907, and again in 1922, this subject of late recurrence was quite fully reported and discussed. In 1907, Ransohoff¹ reported 37 recurrences developing seven years or more

after operation, of which 26 were clearly local or regional and 11 were doubtful. Without making an exhaustive search of the literature, I have collected more than as many more. Of the total number, 31 were insufficiently located in the report, 51 were local or regional, and 12 were more remote. The time of recurrence after operation ran all the way up to 25 years. Over 45 per cent. recurred between 7 and 10 years after operation. The majority of those definitely located in the reports were in the scar or beneath the skin near it.

Different explanations of these recurrences are given. Ransohoff¹ in 1907 gave as the trend of opinion that they result from cancer cells left at the first operation, which have remained latent. However, he adds in conclusion that he is inclined to believe that all supposed very late recurrences in the scar are not such in reality, but that some may be a cancer *de novo* in the scar of an old breast operation. This would be a pathological anomaly, for, after a radical operation, the scar itself and the neighboring tissues do not contain the cellular elements that produce a tumor like carcinoma of the breast.

In the discussion of the question at that meeting, Rodman said that "it would seem also that at least a few of these cases of late recurrence are not recurrences at all. One must demonstrate in every case that the histological type of the secondary growth corresponds in every way to the primary."

However, if the secondary growth corresponds to one of the types of breast carcinoma, it must be a recurrent growth, for, after a radical operation, there is no tissue in or near the scar from which such a growth could originate. In my opinion these local recurrences in the scar or beneath the neighboring skin, probably originate in the lymphatics of the underlying fascia, which have been permeated, as shown by Handley in his book on cancer of the breast.

This is borne out by a statement of Judd's² that "Recurrences in the skin occur more frequently where a large amount of skin has been removed, and the fascia saved, than where less skin was taken and a very free dissection of the superficial and deep fascia made." This indicates that the superficial nodules develop from the lymphatics in the fascia and not in the skin. This has a bearing on the treatment of recurrent nodules, which should be more radical than is customary. The deeper structures should be removed, and not the nodule merely, in order to remove the source of the secondary growth and of possible later recurrences. The failure to so remove recurrent nodules may account for some of the poor ultimate results, as in Case I, reported. Another inference from the above is that greater care should be used in the primary operation to remove the lymph-bearing fascia.

An interesting light is thrown on late recurrences by a German case, referred to by Curtis,³ where at autopsy, five years after removal of a breast, several cancer cells in a quiescent condition, *i.e.*, with no mitoses, were found in the deeper glands of the axilla.

As to the other question, suggested by these cases I have reported, the

occurrence of cancer in the other breast, it might seem at first sight that here there was an independent new growth.

E. S. Judd⁸ states that the opposite breast is involved in 10 to 12 per cent. of late cases. Hubbard¹⁰ also says that secondary growth in the opposite breast occurs in a little over 9 per cent. These figures are far above the normal incidence of breast cancer at the cancer age. A. R. Kilgore,¹¹ in studying the incidence of cancer in the second breast after radical operation, examined 1100 histories, in 659 of which the result for three years or more was known. In this series both breasts were involved 37 times. Both breasts were involved when the patient presented herself in 13 cases, but in most of them the history suggested that cancer originated in one breast and metastasized to the other, rather than that it occurred simultaneously and independently in each breast. Cancer rarely arises simultaneously in both breasts, but the tumor in one precedes that in the other in its origin and development. Kilgore found that if a patient, who has had one breast removed for cancer, survives five years, she is from three to four times more likely to develop cancer in the second breast than a normal woman of the same age in either of her breasts.

This again shows that there is something more than the normal incidence of a second independent new growth.

How does the cancer reach the opposite breast? Bianchetti¹² gives four possible paths. Metastasis, or emboli, in (1) the blood or (2) the lymph. (3) Contiguity. (4) Permeation. As E. S. Judd⁸ says, "Embolism is necessarily an impartial process in which all organs are liable, but cancer is by no means impartial."

Some of the lymphatics which emerge from the breast cross the midline and join those of the opposite breast and even pass to the opposite axilla. Thus Moschcowitz¹³ reports a recurrence of cancer in the opposite axilla 14 years after amputation of the breast. In a permeation of the lymphatics which anastomose with those of the amputated breast we have an explanation of the involvement of the second breast. This permeation may be stimulated into activity, resulting in the formation of a cancer in the second breast, by various stimuli, soon after the development of the first cancer or at a later period, up to 25 years or more. This stimulation of the latent permeated lymphatics is best illustrated by pregnancy, and is brought out in a paper by H. H. Trout.¹⁴ Only 31 of his 173 cases were under forty years of age, and of the 29 of these that were traced, only 2 had become pregnant, but both developed cancer in the remaining breast. Of the 106 patients over forty years, who were traced, only 9 developed cancer in the remaining breast. As a result of a questionnaire, answered by 46 surgeons, only 15 instances were reported where pregnancy occurred after removal of one breast for carcinoma. Thirteen out of these 15 developed carcinoma in the remaining breast and 12 of them died very promptly, as cancer of the breast, associated with pregnancy, is apt to be rapidly fatal. The interval between the first operation and the recurrence with pregnancy varied from two to ten years.

It seems quite evident that there was something left, in or near the breast, from the first carcinoma, that was responsible for the development of the second carcinoma in nearly 87 per cent. of the cases where the breast was stimulated by pregnancy. In other words, one can not escape the conclusion that it was a recurrent growth.

On considering the many instances and forms of late recurrence of cancer of the breast, some would say with Jordan ¹⁵: "In view of such experiences it may well seem a question as to whether we are ever justified in pronouncing a patient cured after operation for carcinoma." This is a somewhat too pessimistic attitude to take.

Is there any hope for better results in the future? I think that we can safely say yes, by the aid of the post-operative, and perhaps the pre-operative, use of the X-ray, given by experts, perhaps using the more intensive penetrating rays, but with due regard to the skin tolerance dose. This treatment has not been in use long enough to enable us to judge of its results by statistics. But the less intensive radiation has given encouraging, though not uniform, results, so that there has been some difference of opinion as to its value. The lack of uniformity is partly a matter of the X-ray operator and the machine and partly the stage and extent of the disease. In a paper by B. J. Lee, ¹⁶ he says: "Sufficient data have already been accumulated at the hospital (Memorial) to make one feel very certain that post-operative X-ray treatment prevents certain recurrences and postpones the appearance of practically all recurrences." He also shows that the treatment of recurrence by irradiation prolongs the life of the patient very materially. Gibbon, ¹⁷ in 1922, said that the results, much better than 10 years ago, are due to the post-operative Röntgen-ray treatment. In a recent paper Summers ¹⁸ says: "Irradiation, if a sufficient dose is given, results in destruction of pathological cells and their replacement by fibrosis; it also results in hyalinization. Hence it is rational." For when fibrosis or hyalinization are present after operation, especially if both are present, life is prolonged very materially, according to MacCarty.⁷

All cases should have an X-ray of the chest, spine and upper half of the femur, as emphasized by Levin, ¹⁹ to determine whether there are any internal metastases in the chest or those bones, that are quite commonly involved. In case there are such metastases the radiotherapy should be directed to these, as well as to destroying all possible foci of local or regional recurrence.

Résumé.—There is no time limit to the occurrence of recurrences. Recurrence is the rule and not the exception, but the ratio decreases in proportion to the time after operation.

Irrespective of the time they appear after operation, local, regionary and metastatic growths are recurrences in the great majority of cases. Permeation of the fascial lymphatics accounts for most of the recurrences in the other breast and locally.

The only way of lessening these is by early operation, wide removal of the deep fascia and post-operative radiation.

GEORGE WOOLSEY

Early radical operation, before the glands are involved, is still the best treatment, gives the best late results and avoids most cases of recurrence.

The X-ray, with or without operation, is the best treatment of recurrent cases and one of the best means of preventing post-operative recurrence.

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IMPROVED TECHNIC FOR INTESTINAL ANASTOMOSIS

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INTESTINAL anastomosis is still confronted by the highest mortality rate of any elective operation within the abdominal cavity, owing to: (1) The

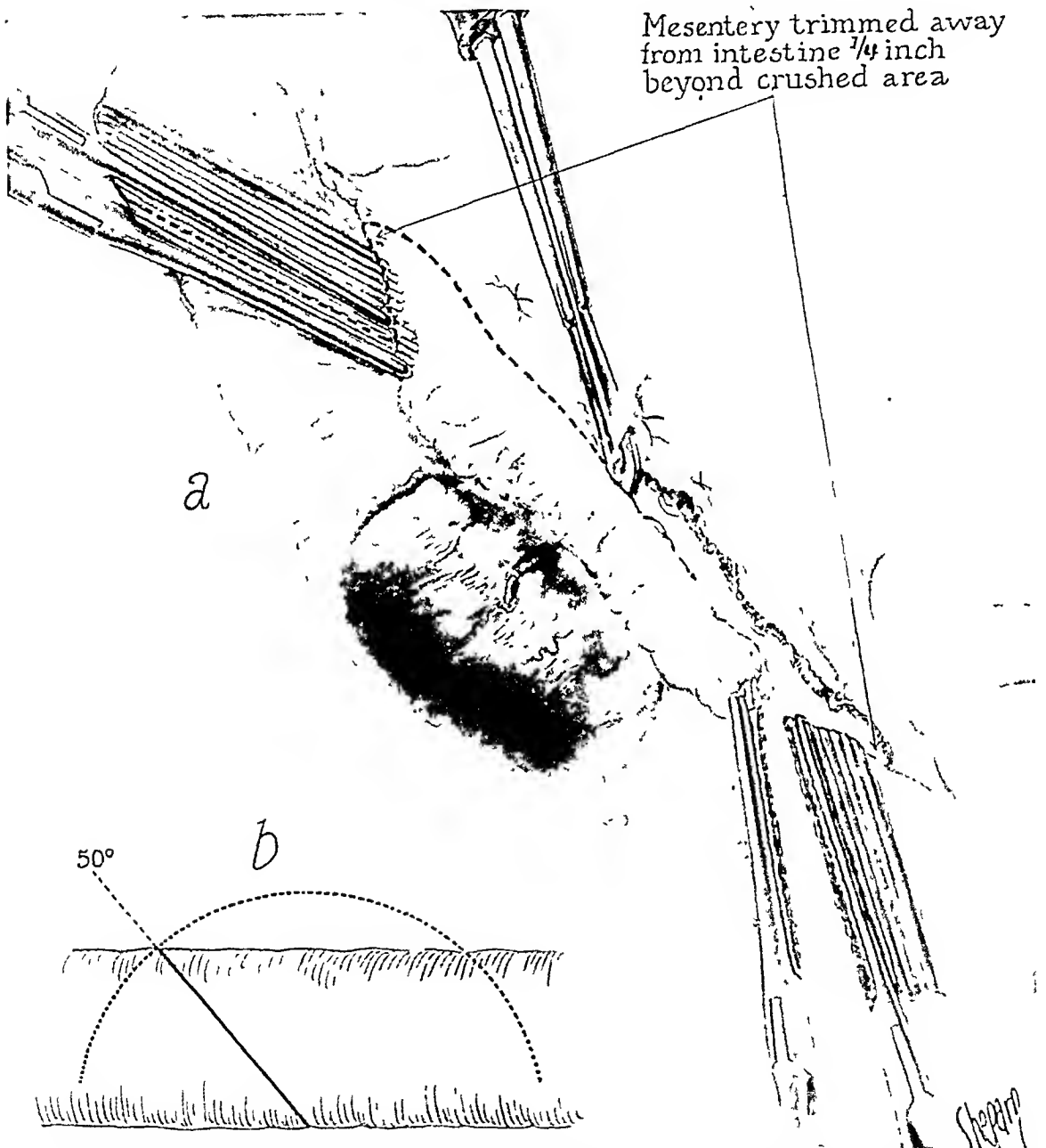


FIG. 1 —The intestine is crushed with a broad Payr clamp, fully one-half of an inch wide, on an angle of about fifty degrees. Thin-bladed Bainbridge retention clamps facilitate later steps. The cautery should not be used to excise the mesentery from the intestine as indicated at the arrow points in the illustration.

lack of aseptic technic, enhanced by the pre-operative morbidity; (2) leakage; (3) secondary obstruction in the area of the anastomosis; and (4) hemor-

rhage into the lumen from the mucosa. Infection from the technic and from leakage are the most frequent causes of failure. From the number of articles constantly appearing, offering as many modifications, it is evident that

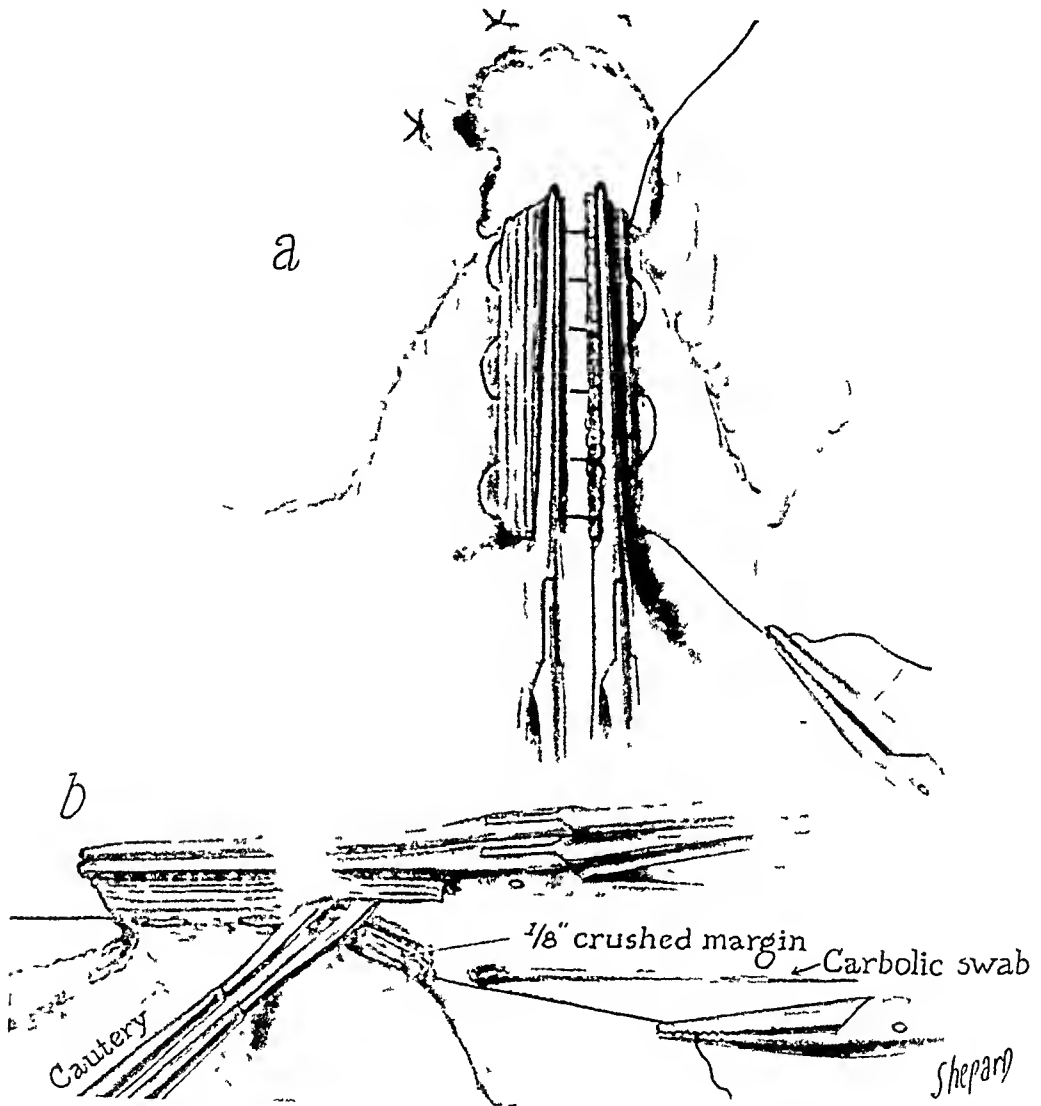


FIG. 2—(a) The retention clamps are brought together and the linen mattress approximating suture is passed through both segments, exactly where the crushed tissue joins the normal intestine. The suture, however, is held taut as it is passed and the clamps are held closely together during the operation. (b) The distal portion of the linen approximating suture, having become contaminated, is swabbed with pure phenol, and the cuff of crushed tissue is reduced with a cautery to a width of one-eighth of an inch.

a new technic which is simple, aseptic and at the same time preserving an ample lumen, is worth while reporting.

The most frequent causes of death following this operation are from, (1) peritonitis, due to infection, directly from the technic or indirectly from leakage; and (2) secondary obstruction, due to the use of internal appliances or a suture technic which inverts too large a rim of intestinal tissue.

The operation I wish to present has been developed with the primary thought of obtaining, with a suture, an ample lumen under as nearly an aseptic



FIG. 3.—(a) The temporary linen approximating suture is held taut between forceps and the anastomosing suture, of silk or oochromic, is started on the side opposite to the approximated crushed edges. (b) The anastomosing suture, having completed one side, is continued in order to cover over the one-eighth inch cuff of crushed tissue on the opposite side. Following this step the opening in the mesentery is carefully closed in two layers in order to cover all raw surfaces. (c) After the union has been completed with one layer of silk or catgut, the proximal portion of the linen approximating suture is cut close to the intestine and pulled through. The anastomosis is then opened by inverting the adjacent intestinal walls through it.

technic as possible, realizing that perfect asepsis is an impossibility whenever the lumen of the intestinal canal is opened or penetrated; perfect asepsis and practical asepsis must be appreciated and differentiated. I have gradually evolved this operation, independently, during the past ten years through experimental surgery upon dogs and operations upon man. Its desirable

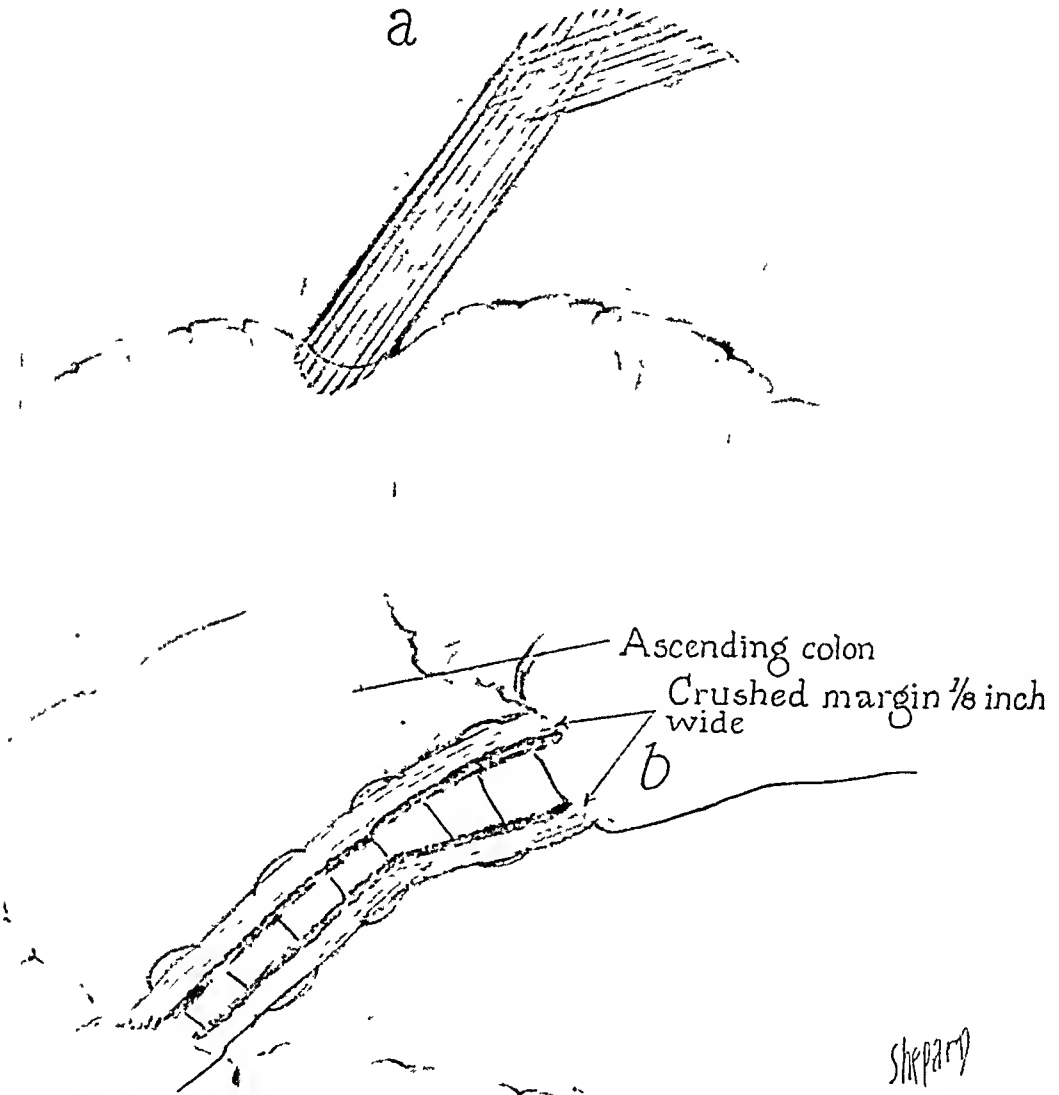


FIG. 4.—A method of end-to-end anastomosis between the large and the small intestine. (a) The small intestine is crushed as illustrated in order to enlarge the opening. (b) The anastomosis carried out as in Fig. 3.

features, with me, have been its ease and rapidity of application, its relatively high degree of asepsis and its resulting large lumen, due to a very narrow rim of intestinal tissue remaining within. It is performed with a single layer of continuous Lembert suture of silk on a fine curved needle, which includes all the coats but the mucosa; a technic I have found, when this single suture is properly applied, is all that is necessary. The intestinal mucosa will not bleed when not sutured, if it is previously crushed and cut with a cautery;

and it will also unite in due time with no secondary ulcer formation. This is not true, however, in gastric surgery.

Technic.—The intestine is crushed three- to four-eighths of an inch wide, on an angle of about fifty degrees; a broad sawed-off Payr clamp makes an ideal crusher (Fig. 1). A long narrow-bladed clamp is applied in the crushed area adjacent to the segment to be resected and another similar clamp placed closely parallel with it; which leaves, for a later step, fully one-fourth of an inch of crushed intestine proximal to the remaining clamp (Fig. 2). The narrow-bladed Bainbridge clamps are used in order to facilitate later steps. The intestine is then amputated with a cautery, and the clamps remaining on the segments to be united are brought closely together (Fig. 1). One continuous mattress suture of fine linen (linen is preferable because it slips through tissues readily) is then passed through both segments, along the edge of the crushed tissue, where it adjoins the normal intestine (Fig. 2A). This linen approximating suture becomes slightly contaminated as it passes through the crushed intestine, but is easily sterilized with a swab of pure phenol (Fig. 2B). This is the only step of any danger and can be safeguarded by simple isolation with packs, and the use of phenol on the suture. We now have the ends of the segments to be anastomosed closely approximated by the single temporary linen suture held taut between two forceps; and distal to the suture we have superfluous crushed tissue which is again amputated with a cautery to within about an eighth of an inch from the linen suture line (Fig. 2B). This leaves a rim of crushed intestine only one-eighth of an inch wide, which is inverted by a single layer of Lembert anastomosing suture of fine silk (Fig. 2B). The anastomosing suture, using the linen approximating suture as a pivot, must be very accurately and uniformly passed entirely around the approximated segments and through the very edge of the uncrushed intestine (Fig. 3). I have found that if the suture is started on the side opposite to the approximated crushed edges, the procedure is greatly facilitated (Fig. 3A). After the anastomosis has been completed (Fig. 3C) the temporary linen suture is cut and pulled through, leaving the crushed edges still obstructing the joined segments. The index finger and thumb then invert the intestinal walls through the rim of the Lembert suture, opening the anastomosis, which will be found to have a lumen amply sufficient. Soft clamps are occasionally applied on the intestine about three inches away from the resected ends in order to retain intestinal contents; however, this is generally unnecessary.

The small intestine is frequently anastomosed, end-to-end, to the large intestine, and I have found that by increasing the length of the crushed area in the small intestine, as in Fig. 4, the operation can be carried out in the same manner as above. Again in this operation the main point in technic is the suturing which must be planned to invert as little intestinal tissue as possible. The illustrations with their legends are far more explanatory.

TRANSACTIONS

OF THE

NEW YORK SURGICAL SOCIETY

Stated Meeting Held October 8, 1924

The President, DR. EUGENE H. POOL, in the Chair

TRANSPLANTATION OF TOE FOR CONGENITAL ABSENCE OF FINGER

DR. HAROLD NEUBOR presented a child, now nine years old, who when seven years of age was admitted to Mount Sinai Hospital in July, 1922, complaining of deformity of both hands, dating from birth. Except for these deformities she was a healthy child. On the right hand the thumb, fourth and fifth fingers are normal, the terminal phalanx of the index finger is missing and practically the entire middle finger. The left hand showed fused stumps of the last three fingers, a normal index finger with constricting bands, and a stump of a thumb. In order to test the quality of repair and to separate the stumps a plastic operation was done on the fused fingers of the left hand. The tissues healed very kindly.

The plans for transplanting the second toe for the absent middle finger of the right hand were then made. By trying various positions it was found that the most advantageous position was obtained by approximating the right hand to the left foot, hence several days prior to operation a plaster-of-Paris casing was made with the child in that position in order to hold her so after operation.

August 1, 1922, the first stage of the operation was carried out. The finger stump was first prepared. A flap with its base on the ulnar side of the stump was turned down, the bone which was cartilaginous in consistency was exposed and its end freshened, the flexor and extensor tendons were freed. The preparation of the toe was as follows: The web between the first and second toe was divided, the incisions extending well up on the dorsum and sole of the foot. To obtain length, it was decided to use part of the metatarsal. One and a half cm. of that bone was exposed and the flexor and the extensor tendons were divided at this level. All the tissues on the outer side of the toe were left intact as it was hoped that the blood supply would be furnished from this side. The skin on the opposite side was undermined slightly to provide for suturing to the skin of the finger, the metatarsal was divided at a point about $1\frac{1}{2}$ cm. from its distal end. The hand was now brought down to the foot, the fingers interlaced with the toes, the flexor and extensor tendons of the finger were united with those of the toe with silk sutures, one chromic suture was used through the bones to approximate them, the skin edges united with horsehair. The child was placed in the plaster casing and the position further maintained by reënforcing with adhesive plaster strips. In her reaction from the anæsthetic the child struggled, and when on the third day the wound was inspected, there was found some separation of the skin edges. These were again approximated and held by means of adhesive plaster.

About twenty-one days later the second stage of the operation was completed. Incisions were made extending well up on the dorsum and sole of the foot between the second and third toes. In the manipulations of detaching the toe it was believed that the extensor tendon suture line was

BRONCHOSTOMY FOR BRONCHIECTATIC SUPPURATION

compromised. It was found also that the head of the metatarsal which was to have been used made too great a bulge in the palm of the hand, so that part of the bone and some excess fat was discarded. The skin was sutured with horsehair. The foot wound was strapped with adhesive.

The day following the operation all dressings except one layer of gauze were removed and the hand kept under a cradle with one electric light continuously burning. The transplant healed very kindly. Sensation began to return after three weeks. X-ray examination made three months later showed the architecture of the bone in the transplant to be normal. Function was limited to slight flexion and extension. The cosmetic result to-day is good, the function is still limited, there is complete sensation, and the X-ray shows the bone to be normal. There has been distinct increase in the length of the finger.

BRONCHOSTOMY FOR BRONCHIECTATIC SUPPURATION

DR. HAROLD NEUHOF presented a woman, who was twenty-two years old when admitted to the medical service of Mount Sinai Hospital in September, 1922, complaining of cough, fever, profuse foul expectoration and hæmoptysis. Because of frequent sore throat she had had her tonsils removed under general anæsthesia three months before admission. Two days after the operation she noted pain in the right chest which radiated upward toward the right shoulder. Forty-eight hours later she had fever. Some time during the second week she began to have profuse purulent expectorations which were blood streaked. This continued up to the time of her admission to the hospital, although there were free intervals when she was afebrile and felt comparatively well.

The patient when admitted had a temperature of 99° and showed on examination dulness with diminished breath and voice sounds and few crepitant râles over the middle lobe, right side. X-ray examination showed infiltration of the middle lobe. During her four months' stay in the hospital she had an effusion at the right base which was spontaneously absorbed, and at times with accession of fever increased signs in her chest which pointed to a spreading pneumonitis. There were several hæmoptyses. Sputum varied up to eight ounces a day and was repeatedly negative for tubercle bacilli. Bronchoscopy showed pus coming from the middle lobe bronchus and there was found one point just at the spur which bled easily and which was cauterized with silver nitrate. The patient was finally discharged, improved, having gained ten pounds in weight.

Five weeks later after several severe hæmoptyses and with profuse foul sputum up to eight ounces a day, she was readmitted, this time to the surgical service. The physical examination was as on previous admission, but this time clubbing of the fingers was noted. X-ray seemed to show involvement of the upper as well as the middle lobe. On January 15, 1923, a thoracotomy and drainage of a bronchiectatic abscess was done. In local anæsthesia 6 cm. of the second rib was resected subperiostially, after which the posterior layer of the periosteum was excised. Through this limited exposure it was seen that the middle lobe was the seat of an infiltration and that the free pleural cavity was sealed off. Repeated aspirations were negative, therefore about 6 cm. of the third rib was removed in a manner similar to the second. Again aspirations were without result. Returning to the second space a little foul fluid was drawn up into the syringe, the lung was entered at this site and partly under guidance of the eye and partly the finger, a dilated bronchus was entered. Three days later it was noted that a good fistula was present, the sputum rapidly decreased to zero. During convalescence an abscess of the thigh developed, which was drained. The bronchial fistula was unfortunately

allowed to close and there was a return of foul sputum with cough, and finally hæmoptyses. The patient was discharged, to be treated by bronchoscopy.

After her discharge she felt well for a short time, but after four months was readmitted with her old complaint. On this admission the X-ray examination seemed to show involvement of the lower lobe. Therefore an exploratory thoracotomy was done, entering the chest by a long resection of the seventh rib. With the exception of one adhesion of the lower lobe to the diaphragm nothing pathological was noted. The chest was closed without drainage. A few weeks later she was discharged to return for further procedures on the upper lobe.

Her fourth admission was six weeks later. At this time the X-ray showed involvement of the upper and middle lobes with several small cavities in the middle lobe. Bronchoscopy again showed that most of the pus came from the middle lobe bronchus.

Operation was again undertaken at the site of the first operation. It was begun in local anæsthesia, but when it was found that a very extensive procedure would have to be carried out, general anæsthesia was given. The old scar was excised and further sections of the second and third ribs removed. Aspirations were without result. It was then felt that the lesion was near the hilum and in order to properly expose this portion of the lung the upper and the middle lobes had to be mobilized. This was accomplished extrapleurally, gradually working around posteriorly and above the apex. When the hilum was exposed aspiration revealed 5 c.c. of foul pus, a rather larger amount than was to be expected, and a large bronchiectatic cavity was entered and drained. As an additional measure packings were so placed extrapleurally that the mobilized lobes were compressed, with the idea of an additional aid in overcoming the infection. The post-operative course was stormy with signs of a pneumonia in the opposite lung. On the twentieth day the patient was discharged with the packings and drain in place. At this time the purulent sputum had entirely ceased, there was but slight cough, and no fever.

The bronchial fistula that was established was maintained for eight months, at which time in addition to being symptom-free the X-ray examination of the chest showed the lungs practically clear. The fistula was then allowed to close. It is closed now about four months, there has been no return of symptoms and the patient appears well. Clubbing of the fingers has disappeared. The patient weighs as much as she did before the illness began. It is now one year since the last operation and, in the absence of any symptoms referable to pulmonary suppuration in this long period, it can be assumed that the patient will remain well.

EXCISION OF BILATERAL PARAFFINOMA OF FACE

DR. HAROLD NEUHOF presented an adult woman who, following an accident which left depressed scars on both sides of her face, had paraffin injected seven years ago. The immediate cosmetic result was good, but somewhat later there was migration of the paraffin and further depression of the scar. About five years ago she began to note trouble in opening her mouth. This interference with function has been progressive until at the time of her admission to the hospital the teeth could be separated for a distance of only $1\frac{1}{2}$ cm.

Examination of the face showed the depression of the scars with a lumpy deformity, the masses extending up over the malar bone and down almost to the ramus of the jaw and deep in the soft tissues. The limitation of function was so extreme that only fluid nourishment could be taken.

Operations were done on one side at a time with a six weeks' interval. The first operation was performed in June, 1924. The procedure and pathology was similar on the two sides. A transverse incision was made parallel to the facial nerve. Excessive bleeding resulted when an attempt was made to free the mass from the overlying skin, so an incision was made through the mass which consisted of paraffin and soft tissues of the face, down to the buccal mucosa, and working from within the mass was not enucleated but literally cut out. In order to obtain closure of the wounds, extension of the incisions had to be made and a plastic repair was done. With the exception of some oily discharge the wounds healed in a normal manner. On one side the facial nerve was injured. While all of the paraffinoma which could be removed was excised, it is not believed that it is all out, as paraffin infiltrated tissue could be seen extending up under the zygoma.

The present scars are no greater than the original ones and the cosmetic result is a great improvement. The functional result is good. The mouth can now be freely opened, although there is as yet far from full freedom of motion of the jaw. There has been progressive improvement since operation and, with the absorption of cicatricial tissue in the operative fields further improvement can be anticipated. No apparatus was employed to stretch the jaws after operation.

DR. WALTON MARTIN said that it is misleading to refer to these cases of paraffinoma as if they were tumors. They are really infiltrations of cellular tissue with warm paraffin and in operating for their removal difficulties are encountered, dependent on this fact.

The infiltrated cellular tissue must be excised. It is usually impossible to shell out a well-defined foreign body. He referred to a patient he had seen several years ago with such a paraffin infiltration in the cheeks and in whom the removal undertaken by Doctor Pool had been very difficult.

DR. JOHN DOUGLAS remarked that in two cases he had seen there was marked telangiectasis of the skin over some of the injected areas which made a bad deformity. Both of these patients were women who had had injections above and in front of the clavicles as well as on the face. In four or five years these became infiltrated and there was present areas of subcutaneous scar tissue that had small globules of paraffin throughout them. In one patient they ulcerated on both sides. In this case an attempt was made at dissection, the operation lasting over two hours one day on one side and again a week later on the other side. After the dissection in this case there was lack of healing. On questioning, the patient denied syphilis, but a Wassermann examination was done, and there was a four-plus reaction. She was given salvarsan and other anti-syphilitic treatment and healing followed. The other woman had a telangiectic deformity also, but so far without ulceration. She refused operation.

DR. HENRY H. M. LYLE said that the pathological condition as described by Doctor Martin was found in a great majority of cases, but that he had encountered a few cases in which the paraffin had remained as a simple plaque. This condition he had found in one case underneath the breast and a second one from the groin.

SUBCLAVIAN ARTERY ANEURISM—LIGATION OF
INNOMINATE—RECOVERY

DR. FRANK S. MATHEWS presented a man, sixty years of age, who was operated on by him eight years ago for subclavian and innominate aneurism. The patient had had syphilis twenty years before. An aneurism had been noted for one year above the right clavicle. Pulse of two wrists equal. Pressure in the two brachials 115 and 130. Right carotid pulsated strongly in the neck. The aneurism terminated abruptly at the beginning of the axillary artery. It was fusiform and extended half-way up the neck, making a sharp turn downward beneath the scalenus muscle. At operation on division of the scalenus, a narrowing of the vessel was apparent with a dilation beyond, continuing downward toward the innominate as far as could be felt. The pneumogastric nerve was recognized as it crosses the subclavian at a point where the vessel was twice the size of a thumb. The thyroid axis was not seen. Evidently the portion of the vessel chiefly dilated was the second and third portion of the subclavian. The operation was performed through an incision along the clavicle for almost its entire length. From its middle an incision extended vertically upward. The omohyoid and most of the sternomastoid muscles were divided. The clavicle was sawed in two about its middle. An inch of the inner segment was removed. On retraction downward, the region of the first rib was well exposed. A double chromic ligature was placed on the apparently normal first portion of the axillary artery. In the narrow portion of vessel lying under the scalenus, between the dilated subclavian and innominate, a strip of fascia lata was wrapped three times, so as to practically obliterate the pulsation in the subclavian. The ends of the fascial suture were fastened with chromic gut. The ends of the divided clavicle were approximated by kangaroo tendon sutures. The patient has been practically well and able to follow his occupation as a tailor ever since. There is no pulse in the right radial artery and the union in the clavicle is shown by X-ray to be fibrous. The heart is large and there is a shadow in the upper mediastinum which would indicate a dilated aorta. He has never had a sufficient amount of anti-syphilitic treatment.

THE INDICATIONS FOR OPERATION IN THE TREATMENT OF
TUBERCULOUS CERVICAL LYMPH GLANDS

DR. JOHN MUNN HANFORD read a paper with the above title, for which see page 885.

DOCTOR HANFORD presented, as illustrating his paper, a woman, twenty-five years of age, single, who was first seen in the Presbyterian Hospital in September, 1922, with a painful swelling in the left side of her neck of two weeks' duration. She had had operations for abscesses in the left side of her neck eight years and four years previously. As a child she had had a congenital dislocation of the left hip. Two operations were done at the New York Hospital, in 1914 and one in 1917. Incision and drainage was done in each case for tuberculous abscesses of the neck. There were no tuberculous nodes present at this time. The abscesses contained about two drams of thick odorless pus. Culture of this pus at the New York Hospital was sterile in broth, for five days. She has been generally well except for the left neck and for a chronic otitis media on the left side with, probably, at one time, a mastoiditis as evidenced by the present X-ray findings of the mastoid. The blood count has been normal; the urine, normal. Wassermann has been negative. X-ray examination of the cervical region in 1922 showed evidence of calcification indicating a probable tuberculosis. In September, 1922, at the

Presbyterian Hospital, incision and curettage of a tuberculous abscess at the same region in the left neck was done and the pathological report was "tuberculous granulation tissue, infected." The culture of the pus was again sterile. Since that time the sinus has never healed. She has been seen frequently; has had twenty-six X-ray treatments to the left neck between November, 1922, and July, 1924, small doses, with an interval of about two weeks. The only focus of infection found that might affect the left cervical lymph-glands was the chronic otitis media on the left side. Tonsils have been removed. In April, 1923, the same region was again operated upon at the Presbyterian Hospital. The scar was excised and abscess cavity was curetted. Again the tissues showed tuberculosis.

The reason for not attempting a complete excision was that the scar tissue of the previous disease and previous operations had probably so involved the eleventh nerve that excision might damage the nerve and give distressing paralysis of the sternomastoid and trapezius muscles. But the neck has never healed.

In January, 1924, another operation was done which consisted of excising the sinus as much as possible and of curetting the depth of the sinus of looking for a foreign body and of trying to determine the direction of the tract. This time the tissue did not show tuberculosis. Following the operation, she had considerable hemorrhage from the wound, probably from a large vein in the region. In April, 1924, the tonsils and adenoids were removed, but no evidence of tuberculosis was found in them. During the past few months there has been no change. Recent X-ray of the mastoids show the right to be apparently normal while the left indicates an old sclerosing process. In August, some 12 per cent. sodium iodide solution was injected into the sinus with the idea of showing up the tract in an X-ray film, when suddenly the patient tasted the salty fluid in her mouth. The X-ray film, however, with this and with bismuth has not outlined anything but a thin streak running from the skin opening into it. Doctor Babcock subsequently examined her and found that the lateral neck sinus communicated with the mucous membrane of her naso-pharynx in the fossa of Rosenmueller. He found no evidence of any primary infection of the nose, throat or sinuses, but did find discharge coming from the tract into the nose. His opinion was that it was probably a branchial cleft remnant with a secondary tuberculous infection which he thought would be very difficult to remove or cure by operation.

DR. CHARLES N. DOWD expressed his appreciation of the careful and valuable work which Doctor Hanford is doing, also concurred with him in his conclusion, that radical removal is the most desirable treatment, when it can be suitably accomplished. The subject seemed, to the speaker, to have several topics which are noteworthy.

First, the problem of the eleventh nerve—the fear of injuring this nerve seems to be the main reason for avoiding operation, or for doing partial instead of complete operations. Injury to this nerve can be avoided in almost every instance. There certainly seems to be no reason for leaving enlarged lymph-nodes in the area marked six after the area marked five has been cleared, for in the proper clearing of area five, the nerve is exposed and after such exposure, there is little likelihood of injuring it. Doctor Hanford has referred to the results in 452 Group 1 cases which Doctor Dowd reported in 1916 with an apparent cure of 91 per cent. In nearly all these cases the

entire bunches of lymph-nodes, including those in localities five and six and down the jugular vein, were removed. The technic of the procedure for these early cases was published in the *ANNALS OF SURGERY*, in August, 1908, and pictures are there given, which show the location of the nerve and the way of avoiding it. After the enlarged nodes have been properly exposed, the capsule of the most prominent node is grasped in toothed forceps; traction is then applied and the adherent tissues about the node are pushed away from its capsule with curved scissors; when some particularly adherent strand prevents blunt dissection a nip of one-sixteenth inch often liberates much adherent muscle or lymph-node, or even vein, as the case may be. During this dissection the course of the nerve may be well located by finding with the finger the transverse process of the atlas; for the nerve, after its emergence from the jugular foramen, is close to this process. It then runs downward, backward and outward until a part or all of it passes into the sternomastoid muscle. It sometimes is included by the various enlarged nodes and this constitutes one of the reasons for careful blunt dissection and the separating of adhesions or of individual nodes as above described. After the most prominent node, the so-called tonsillar node has been removed in this way, the nerve is usually seen for about one inch of its course. When it has thus been located, the rest of the nodes in the sub-mastoid and sub-parotid regions and those in the internal jugular chain can be removed without likelihood of injuring the nerve. This fear of injuring the nerve reminds one of the apprehensions which formerly existed with regard to the facial nerve in the mastoid operation. The fear of injuring this nerve held mastoid surgery back for many years. However, with better anatomical knowledge, these operations are now done in great number and the nerve is seldom injured.

A warning should also be given against injuring the eleventh nerve at the anterior border of the trapezius, a little below the middle of the neck, before its entrance into that muscle. At this point, the lymphatics, the branches of the cervical plexus and the terminal part of the eleventh nerve, lie in close apposition. The lymph-nodes are frequently enlarged here and in removing them the nerve has sometimes been injured, and a corresponding atrophy and disability of the trapezius has followed. In one instance, Doctor Dowd has known such injury to follow an inch incision, which was made for the removal of a single lymph-node, so superficial that it was supposed to be a sebaceous cyst.

Another topic involves the effect of X-ray treatment on other tissues beside the lymphatics of the neck. Much modern work is done on the theory that the X-ray is harmless. But it is not harmless. Cases of sterility have come to the notice of the speaker, which were most unfortunate. Apparently adequate protection by lead is not always possible; at all events, it is not always obtained. Furthermore, other disturbing effects of the X-ray are sometimes very definite. For instance, one of the speaker's patients had ptyalism, so extreme that the amount of saliva almost led to suffocation. In this instance, the mental effect was so profound that at a later time the buzzing of a bee

TREATMENT OF TUBERCULOUS CERVICAL LYMPH GLANDS

suggested the X-ray machine and filled her with terror; and to all appearances she was ordinarily a calm woman with more than the average poise. Again, nausea and a general feeling of depression and weakness are often referred to. The speaker believes that fundamentally the danger of X-ray is greater than the danger of nerve injury.

Another topic refers to the anatomy of the neck lymphatics. This after all is fairly simple. The sub-mental, sub-maxillary, sub-parotid, sub-mastoid and sub-occipital groups form a sort of ring about the base of the skull and they all drain toward the deep cervical chain—the current goes downward and backward. Ascending infection is very rare.

Another topic refers to the duration of treatment. If a patient is kept under treatment for two or three or four years, and if the resources of the family are exhausted in his care, a serious and disturbing condition is created. If the nodes can be removed by operation in three-fourths of an hour and if he can go home in ten days or two weeks and can soon go to school and resume his ordinary activities, there is a great conservation of his health and the resources of the family. The advantage of the short method of treatment is obvious.

DR. FRANK S. MATHEWS said that the collected cases of Doctor Dowd were mainly cases operated on at St. Mary's Hospital, before the days when tonsillectomies were performed, yet these cases of early tuberculous nodes gave excellent surgical results. It is certain, then, that in children with a discrete focus in the tonsillar group of nodes, the excision of the nodes usually results in cure without removal of the tonsils. On the other hand, at the present time, most of the cases which he sees have had the tonsils removed before they came to him for removal of their tuberculous glands. In most cases the parent has been led to believe that the removal of the tonsils would cause a disappearance of the tuberculous glands. His own experience is that tonsillectomy has no considerable effect on the process in the nodes. Occasionally tonsillectomy has been followed by a prompt breaking down of the tuberculous glands—possibly from a secondary infection. It is his feeling that a circumscribed tuberculous focus in the glands should be first removed, to be followed later by a tonsillectomy if it seems indicated by the enlargement or inflammation of the tonsils. In recent years many less cases of tuberculous glands are seen at St. Mary's Hospital for Children, and those seen in private practice have many of them come from outside the city. He is disposed to attribute the change to the improved milk supply. Several cases have been definitely traced to tuberculous cows. At the moment he could not remember a single case in recent years which had been sent to him before the glands reached the abscess stage. In every such case, he regrets that the operation could not have been performed by a shorter, easier dissection, without skin involvement and with less likelihood of scar.

DR. ROBERT T. MORRIS said that after a number of recurrences of tubercular glands and one or two cases of acute miliary tuberculosis following

operation, he began to consider the question of conservative treatment and went over to see Mosetig-Moorhof's work with injections of iodoform in ether. He found that this could be carried out successfully excepting in very young children. All the patients who could be kept under observation made distinct progress. They had, in addition, treatment for tuberculosis, or for the primary focus of infection. There was always the question of operation for glands in which fluctuation could be felt. In trying to differentiate between bovine and human tuberculosis, it was found incidentally that most of the pus was sterile. Operation was not done except where the skin became reddened and thinned. After evacuation of fluid in such cases, the iodoform treatment was instituted and at once the patients got better continuously. Next, Doctor Morris took up the hyperæmia treatment, and this gave good results. He carried this out by having the patient rest the neck on a hot water bag for ten or fifteen minutes and then on a bag filled with cold water, alternating for an hour or more daily. This is the treatment the speaker depends upon chiefly to-day. Sometimes it requires time, perhaps six months or a year before glands cease to give trouble and not all patients will take this time. In addition he gives tuberculin treatment and general treatment for tuberculosis, climatic and nutritional. With the right sort of environment it is unusual for any sort of operation to be required for infected neck glands, in his clinic or private practice.

DR. SETH M. MILLIKEN expressed himself in favor of X-ray treatments in these cases. If the tonsils are taken out and the glands do not subside, they are probably tuberculous and can be treated with the X-ray. If they do subside, the source of infection has been removed.

DR. HUGH AUCHINCLOSS thought that one of the things it might be wise to bring forth was that tuberculosis is a non-vascular disease. Every effort, by whatever means it is attempted, should have a return of good nutrition to the tissues as an axiom. By excision of tuberculous tissue wherever it is possible to do so without doing undue harm, well-nourished tissues are brought in contact with well-nourished tissues and conditions made favorable for permanent cure. This is especially true of the so-called cold abscess.

DR. EDWIN BEER commented on the movement now growing to treat these cases conservatively and referred to a recent publication in which it was stated that 82 per cent. of a group of so-called tuberculous glands of the neck had been cured by heliotherapy. Personally, he had not seen such results; nor had he seen such results from X-ray treatment as Doctor Hanford had called attention to this evening. How sure could one be that in the high percentage of cures reported the glands were tuberculous? There would always be some doubt in such cases. Doctor Beer agreed with Doctor Mathews that the frequency of these cases has diminished in the last twenty years and believed it to be due to the fact that many people now use pasteurized, or Grade A milk, and as many of the infections are bovine infections, the

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control of the milk controls the frequency of the disease. Whether tonsillectomy should be adopted prior to surgical treatment is open to question because with a wound in the throat suppuration may be induced in the glands. It is wise, however, to take out the tonsils if there is only mild glandular involvement for the tonsil is a portal of entry for the tubercle bacillus.

DOCTOR HANFORD, in closing the discussion, said that he would have to learn to take out the glands without injuring the eleventh nerve. Unfortunately, he had often seen the trapezius muscle paralyzed. He had never seen any harm result from X-ray treatments and he had watched these patients for seven years. On the contrary, the X-ray had been beneficial. The first glands involved are usually in the upper cervical group, but by no means are they always the first. Distant glands are sometimes enlarged as the result of an upper focus of infection. He agreed with Doctor Dowd that a cold abscess was not a contra-indication to excision, if feasible. He agreed with Doctor Mathews that tonsils should not be removed indiscriminately; in all his cases where this had been done it was because the nose and throat man thought it advisable *per se*. But, as Doctor Beer had said, the tonsils are occasionally a focus of tuberculous infection even when they appear normal and, if not removed, may cause further trouble in the neck. Doctor Hanford thought the point should be emphasized among the laity and the medical profession that tuberculous glands should be removed in the early stage; and that it is the physician's responsibility to bring these patients to the surgeon before softening occurs.

CORRESPONDENCE

INTRAVENOUS ADMINISTRATION OF UROTROPIN FOR POST-OPERATIVE URINE RETENTION

EDITOR ANNALS OF SURGERY:

Sir:

In the June number of the ANNALS OF SURGERY, Doctor Mills published his most instructive and careful observations on post-operative catheterization. This is a subject of extreme importance and in all probability most of the surgeons have tried something to reduce its frequent use and avoid its dangers.

I would like to call attention to the use of intravenous administration of urotropin in cases of post-operative urine retention, a method that I have described with other prophylactic and therapeutic indications of urotropin in the Archiv für klin. Chirurgie, vol. cxxv, p. 544, 1923. When urotropin is split into formaldehyd and ammonia, this former, after being in contact for a longer period with the mucosa of the bladder, stimulates the detrusor muscle to contract, and—due to its antagonistic innervation—the sphincter to relax, so that the bladder empties itself. No tenesmus or even burning sensation is felt and among the five hundred injections that I made for various purposes, no hæmaturia was noticed. Ten c.c. of a 40 per cent. solution of urotropin are given intravenously at the time when the patient begins to complain of bladder-distention. In operations on the rectum and pelvis, the injection is given routinely eight to ten hours after the operation. Spontaneous urination follows in one to two, not later than five to eight hours.

In bladder paralysis of hysteric origin, that occur in big wards as an epidemic and may even affect pre-operative cases, we may have failures and every other kind of treatment (standing up, thermophor, opening the tap) is equally useless; suggestive therapy is the most effective. But aside from these cases, urotropin always helps, and as it also acts as a powerful inner disinfectant, working in *statu nascendi* at the site of inflammation, wherever this may be, and inhibiting generalized sepsis as shown by Buzello and myself, it is our best prophylactic measure in operations on the meninges, biliary and urinary tract; as a hypertonic solution it acts as a diuretic too, and being strongly alkaline, works against acidosis.

G. DE TAKATS, M.D.,
University of Budapest.

LARGE, MALIGNANT, FACIAL TUMOR REMOVED WITHOUT HEMORRHAGE BY BIPOLAR ENDOTHERMY AND THE ENDOTHERM KNIFE.

EDITOR ANNALS OF SURGERY:

Sir:

Report is herewith submitted of a large tumor of the upper lip in the belief that it will prove interesting from a pathological standpoint as well as from a surgical point of view.

FIG. 1.—a. Tumor involving cheek and upper lip. b. Interior view of mouth showing tumor and crater-like ulceration. c. After plastic repair of lip.



A. G., female, a Pole, aged fifty-eight, was admitted to the Third Surgical Division of Bellevue Hospital, March 4, 1924. At the request of Dr. George D. Stewart the removal of the growth was done, March 13, by the writer with the use of bipolar endothermy and the endotherm knife.

The patient's family history was good, father and mother having died of old age, and two brothers and a sister being alive and well. She was somewhat emaciated and pale



FIG. 2.—Showing condition of patient in September, 1914, six months after operation. No evidence of recurrence or signs of metastasis.

but was able to walk around the ward. (Figs. 1 and 2.) According to her report, the growth had begun some three years before as a sore inside the cheek opposite the right bicuspid. Her teeth began to hurt her and she consulted a dentist who said she had a crooked tooth which might be the cause of the sore. This tooth was drawn but the sore did not heal. It remained small for a year when it began to grow larger. During the six months preceding her arrival at Bellevue it had grown very rapidly and at the time I saw her the mass was the size of an extremely large orange. There was no pain or tenderness, but at intervals the tissue would bleed and parts of it would fall away. It involved the right cheek and upper lip, mainly to the right of the midline. The skin was tense and shiny and there were three spots of ulceration. Dilated veins were seen at the upper and lateral aspect of the mass. Externally the growth extended from 4 cm. anterior to the angle of the mandible on the right side around to the point opposite to the first

incisor tooth on the left side. Interiorly it extended from the last molar to the midline and there was seen a deep crater-form ulceration which extended to the upper lip. The mass was lobulated and tense. Freely movable, it raised the right ala of the nostril and seemed to involve the tissues of the upper lip and cheek only. There were a few palpable lymph glands on both sides of the neck—more on the right.

Since the location and extent of the mass made difficult its removal by the surgeon's knife; on account of the hemorrhage which would have been hard to control, it was decided to employ bipolar endothermy and the endotherm knife in attacking it.

With the patient under ether narcosis the growth was isolated from the surrounding

CORRESPONDENCE

healthy tissue by a wall of coagulation necrosis at its base by the technic of bipolar endothermy. (See *ANNALS OF SURGERY*, vol. lxxix, Jan., 1924, p. 167.) Lymphatics, blood-vessels, and sensory nerves having been thus seared off, the endotherm knife was brought into use by a single turn of a switch on the endotherm. This current of exceedingly high frequency, operating through the same needle which had executed the coagulation wall, quickly excised the tumor without hemorrhage. A clean wound was exposed to which a vaseline dressing was applied.

Convalescence was rapid, there being, as usual, no secondary reaction and no evidence of surgical shock. Patient was able to take food well, the wound sloughed without interference, and nature set about granulating and filling in the excised tissue. No secondary hemorrhage. Wound healed in four weeks. One month later plastic operation was performed by Dr. Arthur M. Wright.

Reports of separate microscopical examinations by Dr. St. George and Dr. Douglas Symmers are subjoined.

Reports of Pathologists. I.—Frozen section; Clinical Diagnosis.—Tumor of mouth—possibly malignant. Pathological Diagnosis.—Infected epithelioma.

Specimen consists of flat crescent-shaped piece of tissue about 1 cm. in its longest diameter. On section the cut surface is dark brown in the upper portion and white at its lower edge. Frozen section shows marked inflammatory hyperplasia of the superficial epithelium associated with the presence of an acute inflammatory change in the sub-epithelial structures.

DOCTOR ST. GEORGE.

II. Clinical Diagnosis.—Tumor of lip. March 15, 1924. Microscopic examination shows the presence of a malignant new growth, the histology of which is slightly suggestive of adamantinoma and were the tumor located in the bone I should have no hesitancy in making a positive diagnosis of adamantinoma. The fact that the tumor was removed from the soft tissues in the vicinity of the lip however, renders this diagnosis highly problematical although one cannot entirely overlook the possibility of an adamantinoma of the soft tissues springing from congenitally misplaced enameloblasts. On the other hand I have seen many striking examples of changes in morphology occurring in metastatic growths, so that the secondary growth bore no resemblance whatsoever to the parent-growth and it is quite possible that the tumor in this particular patient represents a metastatic growth which has so changed its morphology as to resemble an adamantinoma.

The diagnosis of spindle-celled sarcoma must also be taken into consideration, although close inspection of the cells leaves me under the impression that they are epithelial and that the tumor belongs in the group of epitheliomata. There are so many possibilities to be taken into consideration that a positive diagnosis in my opinion at least, is not justified.

(Signed) DOUGLAS SYMMERS,

Director of Laboratories.

The manifest advantages of the employment of endothermy for the removal of such lesions as the one here described and illustrated are—the quickness and ease of its application, absence of hemorrhage, absence of surgical shock, absence of secondary reaction, minimum of trauma, and the reduction of the danger of metastasis and the likelihood of recurrence. Special mention should also be made of the benign feature of nature's quick healing after the malignancy is excised. These results are not, of course, casually achieved. They follow the employment of a definite, specific technic, for endothermy is technic as well as current. No other method enables us first to isolate the lesion and then to excise it by a cutting line which sears

as it cuts. How valuable is this method in the removal of tumors of body cavities as well as tumors of the body surfaces is just beginning to be understood.

GEORGE A. WYETH, M.D.,
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PRIMARY PNEUMOCOCCAL PERITONITIS

EDITOR ANNALS OF SURGERY:

Sir:

According to Rose and Carless, pneumococcal peritonitis is in the majority of cases secondary to a similar infection of the lungs or pleura, the organisms being transmitted by the blood or through the lymphatics of the diaphragm; less frequently the primary focus is in the pharynx or middle ear. Occasionally, they say, the trouble is apparently primary, the pneumococci finding their way through a healthy mucous membrane, as from the bowel or appendix, or more directly by the Fallopian tube.

The condition occurs most frequently in children, especially females, though the number of cases in adults is comparatively high. Lejars quotes a series of 106 cases collected by Jensen, in which 48 occurred in adults and 58 in children. In some cases, the disease is said to occur in an encysted form; in others, the course is acute and surgical interference urgently indicated.

Owing to the comparative rarity of the disease, the following case seems worth recording:

A male, aged eighteen years, was admitted to hospital with the history of having been taken ill suddenly the previous day with acute abdominal pain and vomiting. His bowels had been moved slightly. There was no diarrhoea, which is said to occur frequently enough to be an important diagnostic symptom. On examination, the lower abdomen was rigid and tender without any definite localising signs. The pulse was 104, and the temperature 102.2°.

The condition was thought to be probably appendicitis or possibly a perforation of an abdominal viscus, and an operation was performed immediately. The appendix appeared healthy, and no perforation of a viscus was discovered. There was much pus in the abdominal cavity and this was drained through a median subumbilical incision. Films of the discharge showed numerous bacteria, amongst which were Gram-positive diplococci resembling pneumococci. The patient made an uneventful recovery.

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Smithdown Road Hospital, Liverpool.

BOOK REVIEWS

APPLIED PATHOLOGY IN DISEASES OF THE NOSE, THROAT AND EAR. By JOSEPH C. BECK, M.D. With 268 original illustrations, including four color plates. St. Louis, C. V. Mosby Company, 1923.

No new book on the ear, nose and throat has appeared for many a day with such a wealth of information compressed into one volume as this of Joseph Beck. The arrangement of the chapters may be quoted to show the author's conservative handling of his subject. They are divided thus: Anatomy, functions of the nose, diseases of the nasal chambers, atrophic rhinitis, miscellaneous conditions, the septum and the submucous resection, dips in the nasal bridge, development of the lateral wall, localized anatomy of the lateral wall, head-pains, turbinates, the ethmoidal cells, the sphenoidal cells, the frontal sinus, the maxillary sinus, coronal head sections. The number of illustrations, 268, is large for a book of 334 pages, and much that would occupy pages of text is graphically told by illustration and accompanying legend. The illustrations showing the anatomical development of the nose and nasal accessory sinuses are interesting.

The author emphasizes the value of carefully questioning the patient as to the precise location and nature of "head-pains"; and gives in detail diagnostic characteristics of these pains which may serve to distinguish differentially between sinusitis of the maxillary, frontal, anterior ethmoidal, posterior ethmoidal and sphenoidal cells; and between those lying in juxtaposition to the nasal ganglions and those situated more anteriorly; and also discusses "vacuum headache" and its relation to complaints of the eye, in which the author frequently finds the cause in diseases of the frontal and anterior ethmoidal cells. The book reflects the author's broad experience and matured judgment.

WILLIAM C. BRAISLIN.

NORMAL BONES AND JOINTS, RÖNTGENOLOGICALLY CONSIDERED. By ISIDORE COHN, M.D. New York, Paul B. Hoeber.

This volume represents the fourth of a series of monographic atlases of the ten which are to be eventually published comprising the *Annals of Röntgenology*, by various authors, edited by Dr. James T. Case.

A foreword by Rudolph Matas gives an excellent historical review of the development of radiography. The author has taken up the various appearances of the shoulder, elbow, wrist, hip, knee and ankle and illustrated with excellent plates the appearances seen at various ages, reviewing the literature in each instance and setting forth the observations based on the study of röntgenograms of the parts considered and interpretations of the pictures. In the

BOOK REVIEWS

present volume, the translations into Spanish and French which were incorporated in the previous three, have been omitted, to the benefit of the volume as a whole. As a reference work, it will undoubtedly be greatly appreciated by the profession at large.

JAMES T. PILCHER.

MEMORIAL NUMBER OF THE ANNALS OF SURGERY

WITH this issue of the ANNALS OF SURGERY for December, 1924, the journal completes forty years of publication. During this entire period the editing of the journal has remained under the direction of one man, the one under whose direction the first number was issued, Lewis Stephen Pilcher. As to the character of that direction the steady growth of the ANNALS OF SURGERY in the approval and support of the surgeons of the world is sufficient evidence. At the end of so long a period of such activity, to be still as vigorous and capable in the prosecution of editorial work, is a record which has been rarely equalled.

The publishers of the ANNALS have thought it sufficiently important to be marked by making the issue of January, 1925, a special number, which by its size, the character and number of its contributors, and the quality of its contents should in some measure indicate their appreciation of the eminent service rendered by its editor during so many years. They take pleasure therefore in now announcing that the January, 1925, issue of the ANNALS OF SURGERY will be one of special compliment to DR. LEWIS STEPHEN PILCHER to commemorate the completion by him of forty years of service as its Editor.

J. B. LIPPINCOTT COMPANY.

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The results are on a par with those attained by older methods but the recurrence rate is still far too high. The 3 per cent. reported by Lameris¹⁷ by this method excluded all direct, all strangulated and unusual hernias. If these were included the rate would undoubtedly be far higher. The only really important advance in hernia surgery since 1889 is the principle of overlapping

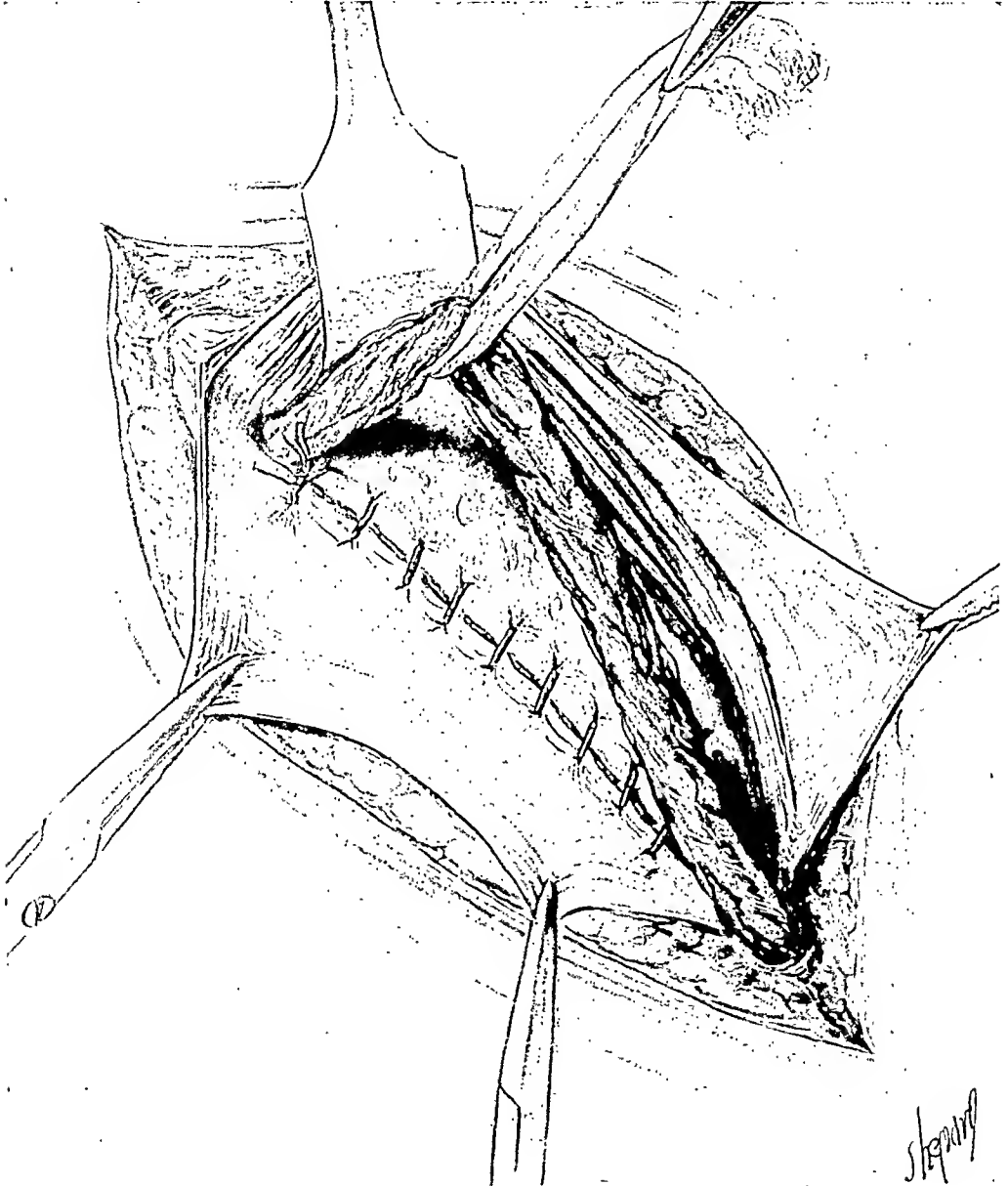


FIG. 4.—Deep layers. White fascia sewn to Poupart's, avoiding red muscle.

the fragments of the external oblique aponeurosis published by E. Wyllys Andrews in 1895⁶⁵ and again in 1905.⁶⁶ It was devised independently in Switzerland by Girard⁶⁷ in 1900 and often goes under his name in Europe. This principle lends itself admirably to adoption in a modified form as a

HERNIOTOMY UTILIZING ONLY WHITE FASCIA

reinforcement for the posterior wall of the canal after full utilization of the endo-abdominal fascia.

Operation.—The operation I have used to meet these conditions utilizes only white fascia to repair the canal, in contradistinction to the use of red muscle.

The canal is laid open in the usual manner and the cord lifted with all its

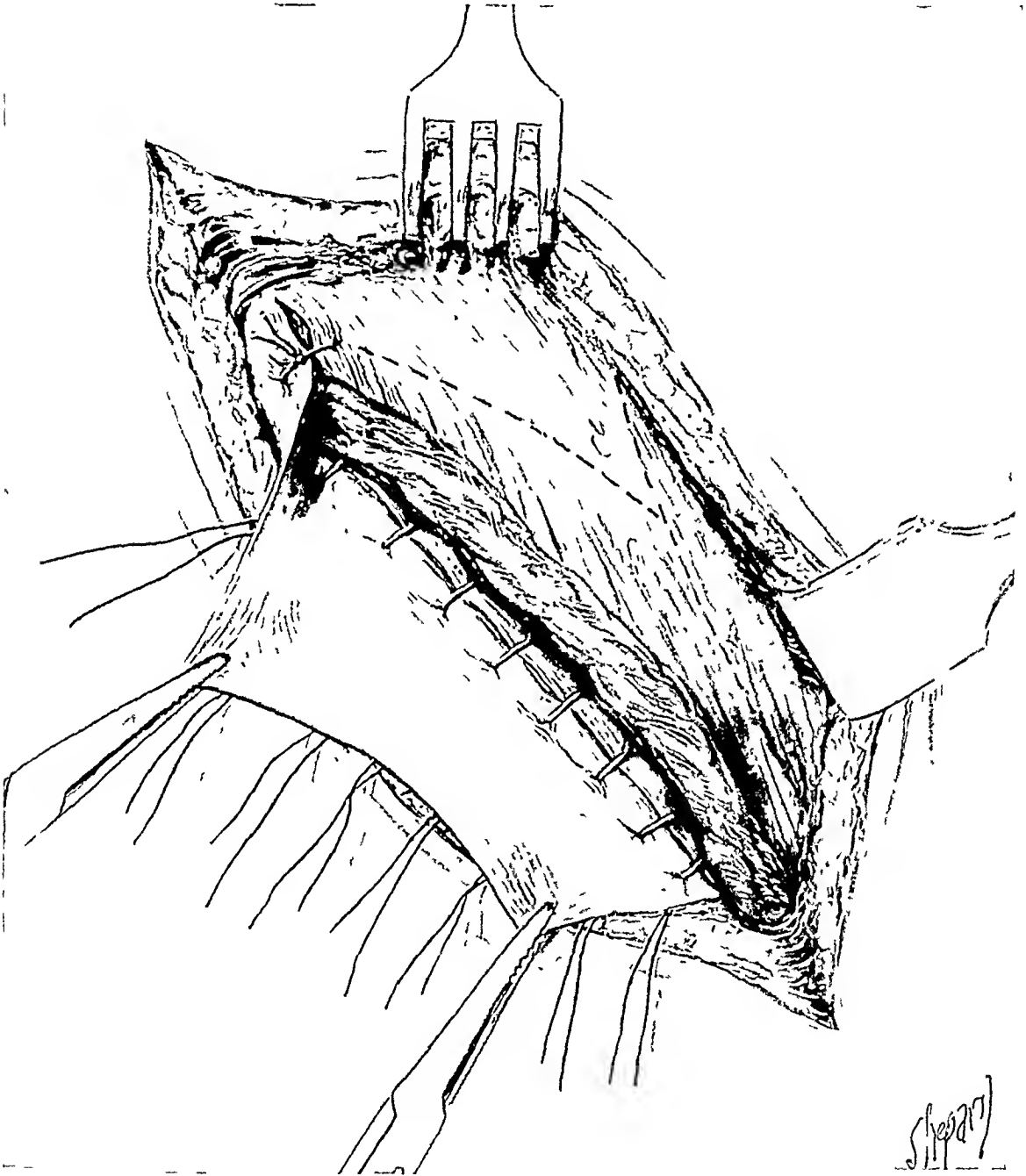


FIG. 5.—Additional layer (external oblique aponeurosis) imbricated behind cord.

coverings. This point is important as it is necessary to clear the floor of the canal of all impedimenta. The cord is then opened, the sac isolated and emptied. The floor of the canal is then cleared of all fat and areolar tissue and the deep epigastric vessels identified and freed so that they may not be injured. The index finger is now inserted into the belly underneath the canal

to act as a guide to our stitching. With this as a safeguard we are able to safely place deep stitches in the deep layers of the abdominal wall. (Fig. 1.) The red muscles are now retracted exposing the endo-abdominal fascia. The type of fascia can now be determined. If the fascia is strong but simply has too large a hole in it our work is easier. By a continuous stitch beginning near the pubis this layer is tightened and the orifice narrowed to the proper dimensions. In the vast majority of cases this fascia, particularly in the part

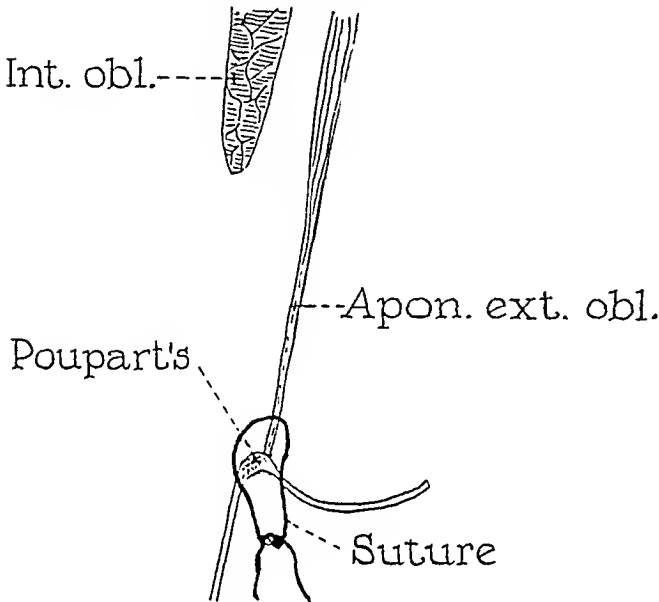


FIG. 6.—Diagram showing knots of deep suture outside fascia.

close to Poupart's, is too lax and thin to be of any value. This thinning, however, is always quite local and in these cases *one never has to go more than 2-3 cm. away from Poupart's to find material of ample strength.* (Fig. 2.) This obviously cannot be sutured to its weak inguinal portion but can very readily be approximated to Poupart's from the pubic spine to the internal ring. I find that this layer is extremely loose, elastic and movable

and in every case have been able to pull it down to Poupart's with a minimum of tension. The suture is best begun near the pubic spine and is continuous right up to the internal ring. The needle first picks up a liberal bite of the endo-abdominal fascia. It is pushed through directly onto the guiding finger, brought out again and then picks up the edge of Poupart's from without inward.

When this manœuvre has been completed, three clamps are placed on the edges of the internal ring which is now a clear anatomical entity. (Fig. 3.) Before in many cases it could not even be recognized. The sac is now trans-fixed, ligated and excised and another stitch or two taken in the endo-abdominal fascia over the stump leaving only a very small hole for the cord. (Fig. 4.)

For reasons above stated the red muscles are ignored.

The upper flap of the external oblique aponeurosis is now sewed to Poupart's ligament with a row of interrupted sutures. (Fig. 5.) These are applied in such a manner that the knots are all lying outside the canal. Each stitch begins in Scarpa's triangle, goes under the ligament, emerges in the canal, gets a bite of the aponeurosis and then goes out through the lower fragment of the aponeurosis close to Poupart's (Fig. 6). I usually put one or two of these stitches above the cord so as to continue the overlapping of the external oblique a little lateral to the canal.

HERNIOTOMY UTILIZING ONLY WHITE FASCIA

The cord is then replaced in its newly formed bed and the lower flap of aponeurosis sutured over it as a roof for the canal. (Fig. 6.)

I use only kangaroo tendon in the closure. As Marcy⁶⁸ demonstrated over fifty years ago (1871), this substance causes less irritation in the tissues, is easier to sterilize with less chemical action and the experience of many

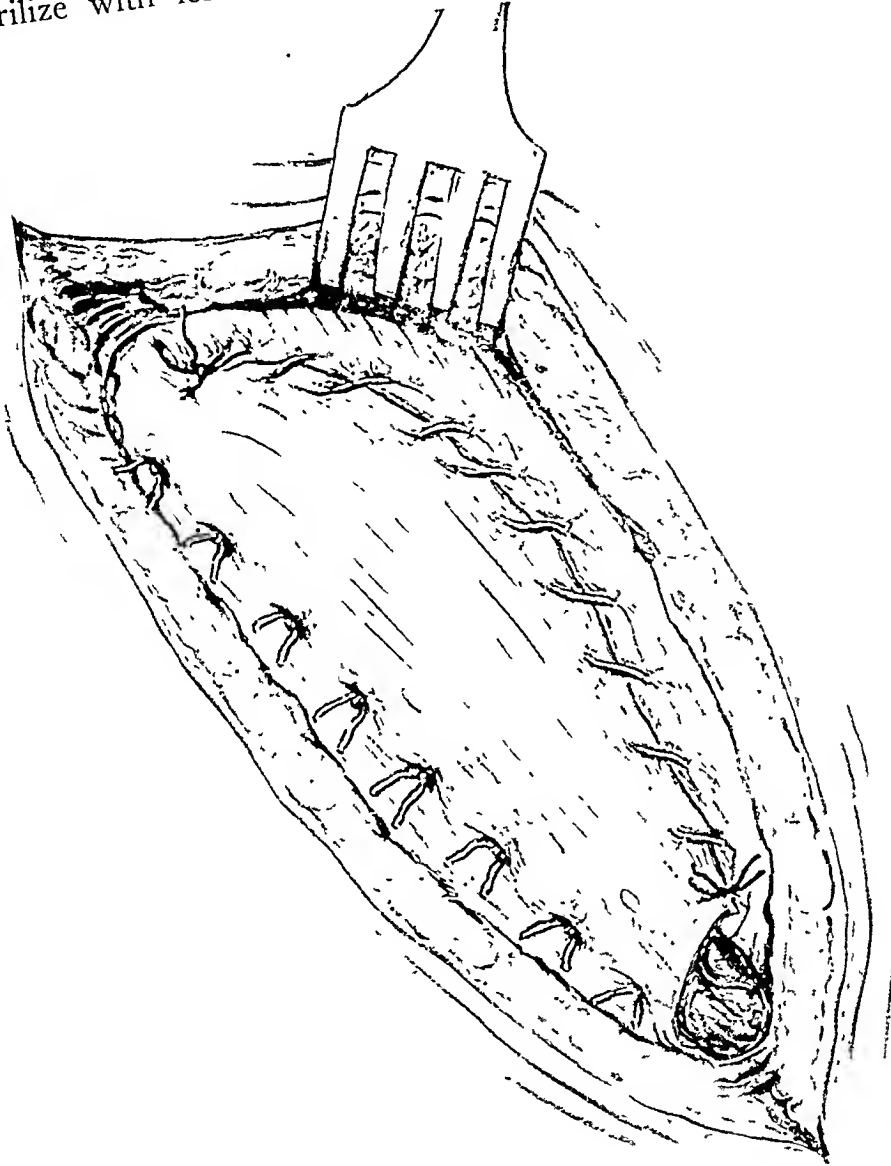


FIG. 7.—Last step of Wyllys Andrews' imbrication suture.

surgeons has amply proved that in practice it is productive of less stitch infection than any other suture material. The only objection to it is the large knots required and this is at least in part overcome by leaving the knots outside the canal.

Discussion.—While the use of the endo-abdominal fascia has been advo-

cated by a considerable number of surgeons especially in recent years, it has usually been dismissed by most with the statement that it is too weak and thin to be of any value. I believe that these failures have been due to the failure to recognize that this deficiency is entirely local. If one takes the average case and pushes ones finger straight down into the abdomen in the lower inguinal region little resistance is encountered. However, if one goes a little distance upward a strong membrane is always encountered. One must remember that this fascia is not normally attached to Poupart's at all, but to the bone under it and therefore it often cannot be found in the space between.

Incidentally my experience has been diametrically opposite from Pitzman's.⁴¹ He says that in the presence of large hernias this layer hypertrophies and it is weakest in the normal. My own observations have been that it is strongest in smaller hernias and is most attenuated in the older larger ones. Of course the sac itself often becomes very thick in large hernias but even in them it is mainly the distal part of the sac and the neck tends to remain thin.

In many cases under the guidance of the finger in the abdomen it is possible to place a row of hæmostats on the endo-abdominal fascia beneath the margins of the retracted muscles and feel it being lifted away from the peritoneum. In such cases the finger safeguard may be dispensed with and our stitches inserted more rapidly and easily. In other cases the fascia and peritoneum are too closely related and the stitches must enter the abdomen protected by the finger.

Since 1918 I have used this method occasionally in small hernias. Recently, however, it has been applied in several large and very difficult ones and the results were so pleasing that it has been adopted as a routine. The inner row of stitches alone appears ample to cure the rupture and if the patient strains or coughs at this point in the operation no bulging will be noted in the floor of the canal. This is true even in the direct type. In direct hernias if a little traction on the cord be made a small oblique sac will always appear. This is probably an artifact in many cases but it serves just as usefully as a point of entrance for the guiding finger. Previous to the adoption of this method I had usually ignored the small dome-shaped sacs in direct hernias, because I was afraid of injuring underlying structures with my needle. I have been quite surprised to find that even the very thin fascia over such sacs becomes quite strong a few cm. away from Poupart's and permits a solid closing of the gap. In all direct hernias I make it an invariable rule to use the rectus sheath in the closure as well as the external oblique aponeurosis. This is best accomplished by the Halsted⁶⁰ technic.

This type of operation may not seem to lend itself so well to the use of local anæsthesia but if for any reason a general anæsthesia is contra-indicated the fascia and peritoneum of the anterior abdominal wall can be blocked above the point of suture underneath the retracted muscles. On the side next to the ligament this infiltration is much more difficult and on account of the fear of injury to the great vessels may not be thoroughly carried out.

HERNIOTOMY UTILIZING ONLY WHITE FASCIA

SUMMARY

1. The importance of the endo-abdominal fascia is emphasized.
2. Considerable evidence is presented that the use of the internal oblique is not only futile, but also probably actually harmful.
3. An operation is described in which the restoration of the canal is made using only white fascia. The floor consists of the endo-abdominal fascia plus the external oblique. The roof of the left-over lower fragment of the external oblique aponeurosis is overlapped or imbricated in front of the cord.

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THE JACK-KNIFE POSITION FOR PATIENTS AFTER OPERATIONS FOR ABDOMINAL HERNIA

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As a means of lessening recurrence, the value of the jack-knife position is not generally appreciated. Much time and skill may be spent in carrying out the minutest steps in technic in a complicated operation, but the position of the patient during the tying of the deep sutures is usually incorrect, and his position in bed after the operation is too often left to the nurse, or to the patient himself, who assumes a position he finds most comfortable.

In the operation for inguinal hernia the best exposure of the field of operation is obtained by keeping the thigh extended until the deep sutures are ready to be tied, when it should be elevated, adducted and rotated inward. This reduces the distance between Poupart's ligament, the internal oblique and conjoint tendon from 25 to 50 per cent., depending on the size of the opening and the development of the muscles and fascia; and the sutures can be tied without tension, even in large hernias.

If the operating table cannot be adjusted so as to elevate the patient's shoulders and knees, the jack-knife position can be secured by the use of pillows, or by placing the patient's foot in a leg holder elevated to the proper position. This relaxed position should be maintained while the patient is transferred from the operating table to his bed.

When the fasciæ and muscles are brought together under tension, there is a natural tendency for the sutures to stretch and the knots to tighten, and as a result the stitches cut through the tissues which also tend to separate parallel with their fibres; consequently the approximated wound edges are not in firm contact and there is often a gap in the interval midway between the sutures.

The patient in bed should have his shoulders and knees elevated 25 to 45 degrees. If this posture cannot be secured by adjustments on the bed, a back rest can be used to raise the shoulders and a pair of pillows placed under the knees of the affected side. (Fig. 1.) The patient is usually more comfortable if both knees are elevated.

The jack-knife position should be maintained for five to ten days, depending on the size of the hernial opening and the tension on the sutures at the time of operation.

The patient is kept in bed ten days to three weeks, depending on the variety of the hernia and the size of the opening. Aged patients are gotten out of bed as soon as possible, and all patients should be cautioned not to do any work for three months after the operation, and only light work for the following six months. They should be warned against a gain in weight,



FIG. 1.—Desirable position after operations for abdominal hernia.

POSITION AFTER OPERATIONS FOR HERNIA

which increases intra-abdominal tension and puts added strain on the wound, thus favoring recurrence. A change of work, which brings new groups of muscles into use thus lessening the chance of recurrence, should be advised.

CONCLUSIONS

The jack-knife position—elevation of the shoulders and knees—reduces the hernial opening 25 to 50 per cent.; facilitates the tying of the deep sutures; takes the strain off the stitches during the process of repair; gives a broad firm union and reduces the percentage of recurrences. This position should be maintained for five to ten days after operation and is usually to be advised for all patients following operation for inguinal, femoral, umbilical and ventral hernia.

THREE THOUSAND CONSECUTIVE HERNIOTOMIES*

WITH SPECIAL REFERENCE TO RECURRENCE, BASED ON EIGHT
HUNDRED AND THIRTY SEVEN FOLLOWED CASES

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ASSISTANT SURGEON TO THE HOSPITAL FOR RUPTURED AND CRIPPLED

DURING the period from August, 1919 to May, 1923, there have been performed at the New York Hospital for Ruptured and Crippled, three thousand operations for hernia. In the period from 1891 to 1919, there were performed seven thousand operations. Thus we have a series of ten thousand consecutive herniotomies performed in an institution where methods of operating, after-care, and follow-up, make statistical study of interest and value. Since a previous communication by Coley (William B.) and Hoguet¹ has dealt with the first series of seven thousand cases, it remains to discuss the later group which differs from the former by reason of the larger proportion of adults, due to the opening of the male adult ward in 1916. Any consideration of results in operations performed for hernia should take into account the age of the patients, and the types of hernia presented. It is of little value to lump all cases together and quote percentage-recurrence based on the entire series. Therefore, each group will be discussed separately. For the purpose of classification, all cases fifteen years of age or over, are considered adult.

Indirect Inguinal Hernia.—1. *In Male Child.*—There were 1013 operations in this group (263 follow-up cases) with no recurrence. This contrasts somewhat favorably with the results in the first 7000 cases where, in 4807 operations, there were 19 recurrences or a percentage of 0.39. We believe that in children, recurrence after operation for indirect inguinal hernia should be reducible practically to zero. The improvement in our later series may be attributable to a better standardization of the Bassini operation which has been the routine operative procedure for this group.

2. *In Male Adult.*—In this class there were 1155 operations, or more than twice as many as had been performed in the first 7000 cases. There were 28 recurrences in 332 followed cases, or 8.7 per cent. All degrees of indirect hernia from bubonocoeles to large scrotal and sliding herniæ are here included. The typical Bassini operation was used in the great majority of cases; but with a suture above the cord to limit the size of the internal ring.

3. *In the Female Child.*—Here were found 124 operations with no recurrence, in the 22 followed cases, which is according to expectation as stated above.

4. *In Female Adult.*—There were 113 operations, of which 23 were followed, with one recurrence, or 4.4 per cent. The lower incidence of recur-

* Read before the New York and New England Association of Railway Surgeons, November, 1923.

THREE THOUSAND CONSECUTIVE HERNIOTOMIES

rence in the female is due, no doubt, in part to the fact that less strain of an occupational nature is thrown upon the repair, but more important is the completeness with which the canal may be closed in the female, as there is no cord to be considered. The operative procedure differs from that employed in the male merely in the fact that the round ligament is not transplanted.

Direct Inguinal Hernia.—1. *In Male Child.*—Four cases only were operated upon (only 1 of which was followed) with no recurrence. This type of hernia is very rare in children. The usual Bassini technic has sufficed to cure the 24 cases that have been observed in this hospital in the entire 32-year period.

2. *In Male Adult.*—Of the 280 herniotomies for direct hernia in male adults, 14 recurred, or 16.4 per cent. of the 85 followed cases. This constitutes the most troublesome group of all, and the various modifications and changes in technic that have been described by a number of writers in the past decade owe their origin to the universal feeling of discontent with results in direct hernia. Where many modifications and new operations are advocated, it can be assumed that no one method is entirely satisfactory. And today the problem of hernia resolves itself largely into the attempt at reducing the recurrence rate of direct hernia. Rectus transposition, imbrication of the external oblique aponeurosis, and other modifications of the ordinary Bassini all have their advocates. There is, however, in the writer's opinion, no one technic applicable to all direct herniæ. The method of approaching each case as an individual, and reserving the decision as to the type of closure to be performed until a survey of the patient's available tissues has been made, seems to be far preferable to the use of any one variation. In the 280 cases here considered, rectus transplant and imbrication of the oblique have been the two modifications most often utilized. An attempt to evaluate their relative merits will be made in a later communication. Suffice it to say here that, many direct herniæ will resist the most skillful and painstaking operative efforts. The occupation of the patient, his age, the size of the hernia, the condition of his abdominal musculature, and the degree of symptoms caused by the hernia, should all be considered before plunging the patient into an operation which, if it fails, may leave him with a recurrence larger than his original hernia and less amenable to treatment with a truss. Downes² has well stated that many a direct hernia is better left unoperated. However, it is the writer's conviction—based on a small number of cases in this group—that the "living suture" of Gallie,³ either in association with a typical Bassini or with some modification (Halsted-Andrews, Schley,⁴ Stetten,⁵ etc.), offers the patient the greatest possible likelihood of a permanent cure; and that when the technic has been mastered and generally adopted, this method will become the operation of choice in selected cases of direct inguinal hernia. Gallie's method forms a bulwark of strips of fascia taken from the thigh and so woven across the defect as to close it without attempting to pull its edges together. It can best be compared to the darning of a hole in a stocking. We have tried this method in a few cases but a sufficient length of

time has not yet elapsed to draw conclusions as to end-results. It seems, however, a most rational procedure. It should be reserved for carefully selected cases as it adds appreciably to the duration of the operation. For this and other reasons, it has not seemed to us advisable in obese subjects or those past middle age. Primary union of the incision on the thigh from which the fascia is obtained has taken place in all the cases we have done by this method. Gallie's own results show 60 cases operated upon more than two years ago with no recurrences. After a sufficient number of cases have been operated upon by this method, and a sufficient period of time has elapsed, the results of the "living suture" method in our cases will be the subject of a later report.

3. *In Female Child*.—No case has ever been operated upon at this institution.

4. *In Female Adult*.—Three cases were operated upon, two were traced, with one recurrence, or 50 per cent.

Though rare, when present this variety of hernia offers as apparently great an obstacle to permanent cure in females as in males, the percentage-recurrence in the entire 10,000 series being 12.5 per cent. of 24 cases.

Direct and Indirect Hernia (Saddle-bag Type)

1. Male child 2 cases, neither traced.
2. Male adult 98 cases with 5 recurrences, or 11.9 per cent.
of 42 followed cases.
3. Female child 0 cases observed.
4. Female adult 1 case, not followed.

This condition is essentially one of adult life and is rarely observed in females. Its recognition is quite important as in those cases in which the indirect sac is more pronounced, failure to find the direct portion will almost inevitably lead to a recurrence. For the treatment of this variety of direct hernia—for so it should be regarded—we adopt the principles applicable to simple direct hernia-repair. The disposition of the sac, however, is a point worthy of consideration. The most convenient and logical procedure is that suggested by Downes, namely, conversion of the two sacs into one, by peeling the deep epigastric vessels off the isthmus with the finger introduced through the opened indirect sac into the direct. Thus one large and broader "indirect" sac is produced and the high ligation effected as in any indirect hernia. Should it be difficult to perform this manœuvre, as when operating under local anaesthesia, one may divide the vessels between ligatures.

Femoral Hernia.—1. *In Male Child*.—Eleven cases with no recurrence but 10 of the 11 cases were not traced.

2. *In Male Adult*.—There were 32 operations (11 followed) with one recurrence, or 9.09 per cent.

3. *In Female Child*.—Ten operations with no recurrence, only two cases having been followed.

4. *In Female Adult*.—There were 48 operations with 2 recurrences, or 14.2 per cent., based on the 14 followed cases.

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TABLE I
Summary of 3000 Consecutive Herniotomies.

Type	No. of operations	6 mos.— 1 yr. followed	1 yr. or over followed	Total	Recur.	% Recur.
Inguinal male child indirect.....	1013	89	174	263	0	0
Inguinal male adult indirect.....	1155	103	229	332	28	8.7
Inguinal male child direct.....	4	0	1	1	0	0
Inguinal male adult direct.....	280	28	57	85	14	16.4
Inguinal male child direct and indirect..	2	0	0	0	0	0
Inguinal male adult direct and indirect..	98	19	23	42	5	11.9
Inguinal female child indirect.....	124	10	12	22	0	0
Inguinal female adult indirect.....	113	7	16	23	1	4.4
Inguinal female child direct.....	0	0	0	0	0	0
Inguinal female adult direct.....	3	2	0	2	1	50
Inguinal fem. child direct and indirect	0	0	0	0	0	0
Inguinal fem. adult direct and indirect	1	0	0	0	0	0
Femoral male child.....	11	1	0	1	0	0
Femoral male adult.....	32	8	3	11	1	9.09
Femoral female child.....	10	0	2	2	0	0
Femoral female adult.....	48	4	10	14	2	14.2
Umbilical male child.....	11	0	3	3	0	0
Umbilical male adult.....	11	2	1	3	0	0
Umbilical female child.....	9	2	0	2	0	0
Umbilical female adult.....	23	6	4	10	1	10
Ventral male child.....	5	2	2	4	0	0
Ventral male adult.....	14	2	3	5	1	20
Ventral female child.....	1	0	0	0	0	0
Ventral female adult.....	18	1	3	4	1	25
Epigastric male child.....	2	1	1	2	0	0
Epigastric male adult.....	9	2	2	4	1	25
Epigastric female child.....	0	0	0	0	0	0
Epigastric female adult.....	3	0	2	2	1	50
	3000	289	548	837	57	6.8

* The floating character of the foreign-born patients makes circular follow up letters a rather ineffectual method of recalling them for periodic examinations and is an expense to the hospital. Personal contact between operator and patient is more productive of good results. The earlier series reported by Bull and Coley showed a much higher proportion of cases followed. We feel that the percentage in this series traced longer than six months, (837 in 3000 or about 27 per cent.) is far too low and efforts are now being made to materially improve this.

In view of the numerous communications advocating the inguinal approach for femoral herniotomy, it might be well to state our position. Though we have occasionally tried out this method, we have used and continue to use the femoral approach with closure by purse-string of the femoral canal, first, because it has seemed a far simpler procedure and has served us well, there being but 3 recurrences in 28 followed cases; and second, because none of the advocates of the inguinal route has thus far been able in a conclusive series to show a lower percentage of recurrence. Should statistics ultimately show the inguinal route to be productive of a higher percentage of cures, the more complicated method would then become justifiable, as a routine procedure. In strangulated femoral hernia, the inguinal approach is admirable.

Umbilical Hernia.—1. *In Male Child.*—Eleven cases with no recurrence, 3 cases having been followed.

2. *In Male Adult.*—Eleven cases with no recurrence, 3 cases having been followed.

3. *In Female Child.*—Nine cases with no recurrence, only 2 cases having been followed.

4. *In Female Adult.*—Twenty-three cases with one recurrence, or ten per cent. of ten followed cases.

The usual type of Mayo overlapping operation has proved satisfactory in these cases. We have found that the majority of umbilical herniæ in very young children respond to strapping with the button, and hence, operation is seldom performed under the age of twelve years. If strapping fails, we see no object in postponing operation thereafter.

Ventral Hernia.—1. *In Male Child.*—Five cases; 4 followed with no recurrence.

2. *In Male Adult.*—Fourteen cases; 5 followed, with 1 recurrence or 20 per cent.

3. *In Female Child.*—One case, not followed.

4. *In Female Adult.*—Eighteen cases with 1 recurrence or 25 per cent. of 4 followed cases.

The usual lateral overlapping operation with suture of the abdominal wall in layers, where possible, has been the customary procedure.

Epigastric Hernia.—1. *In Male Child.*—Two cases, both followed, no recurrence.

2. *In Male Adult.*—Nine cases, 4 followed, with 1 recurrence or 25 per cent.

3. *In Female Child.*—No cases.

4. *In Female Adult.*—Three cases, 2 followed, with 1 recurrent or 50 per cent.

Double Hernia.—In compiling the statistics for this paper, it seemed of interest to determine the number of instances in which a hernia was present on both sides; these findings are given in Table II. Attention is called to the fact that, while these figures represent the cases operated upon in which a

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hernia was found on both sides at the time of operation, there are also a number of cases, particularly in children, in which, after operation on one side, a hernia has developed within a year on the opposite side, which was not detected at the time of the original operation. Some surgeons believe the development of an indirect inguinal hernia on the opposite side in children is of so frequent occurrence that, in finding this type of hernia on one side, they immediately operate upon the opposite apparently normal side often finding a small incipient hernia which had escaped detection during the routine examination prior to operation. It is not our opinion that a double operation

TABLE II
Incidence of Double Hernia in 3000 Cases.

Double indirect male adult	255
Double indirect male child	210
Double direct male adult	82
Double direct male child	0
Double direct and indirect male adult	22
Double direct and indirect male child	0
Double indirect female adult	24
Double indirect female child	27
Double direct female adult	0
Double direct female child	0
Double direct and indirect female adult	0
Double direct and indirect female child	0
Double femoral male adult	5
Double femoral male child	2
Double femoral female adult	9
Double femoral female child	0
Total	636
Incidence	26 per cent.

should be routinely performed in all unilateral indirect inguinal herniæ in children; and we believe that if a large series of cases were considered, the percentage in whom a second operation was made necessary by the subsequent development of a hernia on the opposite side, would be very much smaller than the percentage in whom a second hernia had not developed.

Undescended Testis.—As the subject of undescended testis will be fully discussed in a later communication, we will merely mention here that, in the 3000 cases of hernia, there were 39 operations for undescended testis in adults, and 90 in children. The undescended testis was right-sided in 32 instances in adults, and 41 in children; left-sided in 7 of the adults, and 49 of the children. The constant finding of an associated congenital hernia, either fully developed or potential, needs only to be mentioned in passing.

Recurrences.—At present, the chief interest in the subject of hernia lies, not in a consideration of successful operations, but rather in an analysis of failures. It would seem that there are two distinct sets of factors which may be held accountable for recurrence following an operation for hernia. The first, comprises factors inherent in the individual subject, *e.g.*, the age, occupation, size of the hernial orifice, lack of development of the abdominal muscles, especially deficient conjoined tendon, presence of adipose tissue in abnormal

amounts or abnormally placed, presence of a sliding hernia or a strangulated hernia with the patient in a critical condition. These factors are for the most part beyond the control of the operator and in so far as they play an important part in the causation of recurrences, just so far will operative efforts continue to meet with ultimate failure. It is particularly in individuals who present a combination of several of these factors that recurrences are most certain to follow. Some should, undoubtedly, be advised against operation, and more care in selecting cases for operation will reduce the rate of recurrence in this group and work for the ultimate benefit of the patient. In the second group may be placed those factors which do not properly belong to the patient himself and over which the surgeon has or should have control. Here we include failure to recognize and satisfactorily obliterate the sac or both sacs where the hernia is of the saddle-bag type. This is the probable explanation of several recurrences which were noted directly the patient was allowed out of bed. The presence of infection markedly predisposes to a recurrence and, indeed, may be looked for, should it involve the deep layer of sutures. As a corollary the use of non-absorbable suture material which predisposes to sinus formation is a factor in recurrence. Such apparently trivial matters as the length of time the patient is kept in bed, the failure to provide support by careful adhesive strapping or spica bandage during the healing period, or to forestall the development of post-operative bronchitis or pneumonia with its attendant cough—these may turn the scale and favor the formation of a recurrence despite faultless operative technic.

Here, too, may be raised the question of re-operation on a hernia that has once recurred; particularly in inguinal hernia there is much to persuade one that many patients with recurrence had better wear a truss than undergo a second operation. This, of course, refers to the direct recurrences more especially, though, as a matter of fact, the majority recur as direct and not as indirect. It is interesting to note that of 47 recurrences of inguinal herniæ (direct or indirect) in male adults in this last series, 6 or 12.7 per cent. had followed previous recurrences. In carefully selected cases, recurrent herniæ treated by some form of fascial transplant, the most rational of which seems to be the "living suture" repair of Gallie, will probably be successful.

Interval between operation and recurrence.—In the 57 recurrences in this series of consecutive herniotomies, the average elapsed time between operation and recurrence was 7.1 months. The longest elapsed time was 31 months. There were five instances in which recurrence was noted during the first month after operation: In one of these cases, a direct sac was presumably overlooked in the repair of an indirect inguinal hernia; in another, an epigastric hernia, the sutures gave way while the patient was still in the hospital; a third was recurrent when operated upon and a second recurrence promptly supervened. Although we attempt to follow all cases for five years or more, and some of the earlier ones have been traced over twenty years, it is evident that if cases are observed for two years, the majority of recurrences will be detected.

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TABLE III.

Classification of Fifty-seven Recurrences in 3000 Cases

No.	Sex	Age	Type of hernia	Interval	Type of op. performed	Type of recurrence
1	M.	47	L. D. I. H. recur.; R. O. I. H.	3 mos.	Bassini	L. recurrence, prob. as direct.
2-3	M.	56	D. D. I. H.	8 mos.	Bass., imbrica. Trans. f.	Double recur- rence.
4	M.	24	R. I. Superf., Und. T.	18 mos.	Bass., cord not transpl.	R. recurrence prob. indirect.
5	M.	37	D. O. I. H., double varico- coele	18 mos.	Bass. with double varicocœle op.	R. recurrence.
6	F.	35	R. O. I. H.	5 mos.	Bass. round lig. not tr.	R. recurrence.
7	M.	55	R. D. and O. I. H.	4 mos.	Bassini	R. recurrence prob. as indirect.
8	M.	37	L. O. I. H.	1 yr.	Bassini	L. recurrence prob. as direct.
9	M.	40	R. O. I. H. and L. D. I. H.	16 mos.	R. Bass.; L. Bass., R. T.	R. recurrence.
10	M.	17	D. O. I. H.	5 mos.	Bassini	R. recurrence.
11	M.	53	L. O. I. H.	2 mos.	Bassini (good clo- sure)	L. recurrence.
12	M.	42	D. D. I. H.	Immed.	Bass., imbrica. Ext. Obl.	L. recurrence.
13	M.	30	L. O. I. H.	31 mos.	Bassini	L. recurrence at int. ring.
14	M.	30	D. D. I. H.	2 mos.	Bassini R. T., im- bric. Ex. Obl.	R. recurrence as a direct.
15	M.	42	D. D. I. H.	5 mos.	Bassini with R. T.	L. recurrence.
16	F.	65	Umbil. H.	6 mos.	Mayo overlap- ping	Large recurrence.
17	M.	40	D. D. and O. I. H.	6 mos.	Bassini with R. T.	R. recurrence.
18	M.	42	L. O. I. H.	2 mos.	Bassini	L. recurrence faint impulse.
19	M.	30	R. D. I. H. and L. O. I. H.	6 mos.	Bassini	R. recurrence as direct
20	M.	45	R. O. I. H.	9 mos.	Bassini	R. recurrence.
21	M.	44	R. O. I. H.	4 mos.	Bassini	R. recurrence as direct.
22	M.	40	Ventral H.	7 mos.	Mayo overlap- ping	Recurrence throughout in- cision.
23	M.	48	L. O. I. H.	2 mos.	Bass., imbric. Ex. Obl. over cord	Recurrence at lower angle.

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TABLE III.—*Continued.**Classification of Fifty-seven Recurrences in 3000 Cases.*

No.	Sex	Age	Type of hernia	Interval	Type of op. performed	Type of recurrence
24	M.	27	L. O. I. H.	11 mos.	Bassini	L. recurrence.
25	M.	40	D. D. I. H.	1 yr.	Bassini, rectus imbr. Ex. O.	R. recurrence.
26	M.	48	L. D. I. H.	1 mo.	Bassini	L. recurrence.
27	M.	42	L. D. I. H.	2 mos.	Bassini and Halstead	L. recurrence.
28	M.	29	L. O. I. H.	8 mos.	Bassini	L. recurrence.
29	M.	45	R. O. I. H. recur.	3 wks.	Bass. R. T. and imbr. Ext. O.	R. recurrence lower angle, D?
30	M.	35	L. D. and O. I. H., R. O. I. H.	Immed.	Bassini	R. recurrence on getting out bed.
31	M.	36	D. D. and O. I. H.	18 mos.	Bassini with R. T.	L. recurrence.
32	M.	57	D. D. I. H. recur.	2 mos.	Bassini with R. T.	L. recurrence, slight.
33	M.	43	V. H., R. D. I. H.	21 mos.	Bassini with R. T.	R. recurrence, D. slight.
34	M.	21	L. O. I. H., Und. Testis	17 mos.	Bassini, cord not tr.	L. recurrence.
35	M.	32	R. O. I. H.	3 mos.	Bassini	R. recurrence.
36	M.	32	D. D. and O. I. H.	9 mos.	Bassini?	L. recurrence.
37	F.	53	Ventral H.	6 mos.	Vertical overlapping	Ventral.
38	F.	55	R. D. I. H., L. O. I. H.	6 wks.	Bassini R. L. N. T.	R. recurrence.
39	M.	40	D. O. I. H., R. Und. Testis	6 mos.	Bassini	L. recurrence.
40	M.	48	D. D. L. H. recur.	3 mos.	Bassini, imbr. of Ext. O.	L. recurrence.
41	F.	52	Epigastric H.	4 mos.	Mayo overlapping	Recurrence throughout inc.
42	M.	29	L. D. I. H.	11 mos.	Bass. with lower two sut. incl. rectus; Imbr. Ex. O.	L. recurrence.
43	M.	38	D. O. I. H.	13 mos.	Bassini	R. recurrence.
44	M.	51	D. O. I. H.	4 mos.	Bassini	R. recurrence.
45	M.	47	R. recur. I. H., indirect	10 mos.	Bassini, rectus transp.	R. recurrence, middle of incision.
46	F.	38	L. F. H.	7 mos.	Two purse-strings	Recurrence.
47	M.	30	D. O. I. H.	4 mos.	Bassini C. N. T.	L. recurrence.

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TABLE III.—*Continued.*

Classification of Fifty-seven Recurrences in 3000 Cases.

No.	Sex	Age	Type of hernia	Interval	Type of op. performed	Type of recurrence
48	F.	48	D. F. H.	7 mos.	Two purse-strings	R. recurrence.
49	M.	38	D. O. I. H.	4 mos.	Bassini	R. recurrence.
50	M.	45	R. O. I. H.	4 mos.	Bassini	R. recurrence, direct, small.
51	M.	38	L. O. I. H., recur.	10 mos.	Bass. with rectus trans.	L. recurrence.
52	M.	55	D. F. H.	1 mo.	Two purse-strings Imbr. Ext. Obl.	R. recurrence.
53	M.	63	R. O. I. H. recur.	6 wks.	Bass. apon.; vas and vessels emerging separately	R. recurrence slight at lower angle.
54	M.	39	E. H.	Immed.	Vert. overlap. Mayo	Recurrence.
55	M.	24	R. O. I. H.	1 mo.	Bassini	R. recurrence, direct.
56	M.	42	D. D. and O. I. H.	2 yrs.	Bass. with Imb. Ext. Obl.	L. recurrence, direct?
57	M.	16	D. O. I. H. and Ventral H.	2 yrs.	Bass, lateral overlap.	R. recurrence.

Age at Operation.—The average age at operation in the recurrent cases was 38.1 years. The females averaged 45.1 and the males 38.6. The youngest recurrent case was 16 years, and the oldest, 65 years; the former, a double indirect inguinal and ventral hernia in a male, and the latter, an umbilical in a female.

Classification of Recurrences

Indirect inguinal, 8 in 1268 adult operations
Direct inguinal, 16 in 283 adult operations
Direct and indirect, 5 in 99 adult operations
Femoral, 3 in 80 adult operations

Ventral, 2 in 32 adult operations
Epigastric, 2 in 12 adult operations
Umbilical, 1 in 34 adult operations

No recurrences in children.

Explanation of Recurrences.—Since a recurrence is often the result of a combination of several factors, any discussion may be considered theoretical; moreover, we are hampered by the fact that in most cases the records fail to state the opinion of the operator as to the cause of failure. This is inevitable in a follow-up system where the cases are examined by members of the entire staff at random, though this method probably results in more unbiased examinations. In six instances, recurrence followed operations for previous recurrences; in two, the hernia was of the sliding variety, with the implied failure to obtain a high closure of the sac. Infection and drainage of the wound was the probable cause in two cases, and in two others, associated with undescended

testis, the cord was not transplanted. In one instance, a direct sac was probably overlooked, and two were attributed by the operator, to poor closure due to deficient musculature.

Disposition of Recurrences.—In general, the decision as to treatment of recurrent cases depends upon the type and size of the recurrence, the age and occupation of the patient, and the condition of the musculature. For the most part, small direct recurrences are generally given a well-fitting truss. A few are given the choice of operation, though it is not urged upon them.

TABLE IV
Deaths in 3000 Consecutive Herniæ

No.	Sex	Age	Type of hernia	Operation performed	Time of occurrence of death	Cause of death
1	F.	50	Umbilical; strang.	Mayo overlapping	Died on table	Anæsth., shock, obstruction.
2	M.	67	R. O. and Direct Ing.	Bassini, rectus trans.	5th post-op. day	Post-anæst., pneumonia.
3	M.		L. D. I., L. Hydrocele	Bassini, rectus trans.	5th post-op. day	Pulmonary embolus.
4	F.	55	Post-op. Ventral	Lateral overl. modified	4th post-op. day	Paralytic ileus.
5	M.	59	R. O. Scrotal, recur.	Bass., Imbrica. oblique	14th post-op. day	Renal insuf. Hypo-sta., Pn.
6	M.	3	L. O. I. H. scrotal	Bassini	2nd post-op. day	Acidosis.
7	M.	25	L. O. I. H. recur.	Bassini, rectus transp.	Not stated	Post-op. pneumonia.
8	M.	43	R. O. I. H.	Bassini	4th post-op. day	Post-op. pneumonia.
9	M.	81	Double D. I. H.	Bassini under local an.	2nd post-op. day	Pulmonary embolism.
10	F.	32	R. Femoral H.	Mod. Cushing; 2 purse-s.	5th post-op. day	Pulmonary embolus.
11	M.	6	Double O. I. H.	Bassini	3rd post-op. day	Acidosis; convuls.

Two cases were re-operated upon elsewhere, one having become strangulated. Though our records are incomplete in this respect, it would seem that about twenty-five per cent. of the recurrences were re-operated upon by us, the remainder being given some form of retentive apparatus. Some have undoubtedly sought re-operation elsewhere. As we become more familiar with the Gallie "living suture" technic, it is not unlikely that the field of operability of these recurrent cases will be greatly extended; and already we are offering operation to patients whom we would have felt had but slight likelihood of a cure by any other procedure.

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Type of Operation Performed in Cases which Recurred

Inguinal Hernia.—Simple Bassini with cord transplantation	25 times
Simple Bassini with cord not transplanted	2 times
(Both cases associated with und. test.)	
Simple Bassini with round ligament not transplanted	2 times
Bassini with rectus transplantation	9 times
Bassini with imbrication of ext. obl. aponeurosis	7 times
Bassini with rectus transposition and imbrication of ext. obl. aponeurosis...	3 times
Femoral Hernia.—Modified Cushing purse-string	4 times
Ventral Hernia.—Vertical overlapping	1 time
Mayo overlapping	1 time
Epigastric Hernia.—Mayo overlapping	2 times
Umbilical Hernia.—Mayo overlapping	1 time

Technical Considerations.—The methods of operating upon hernia used at the Hospital for Ruptured and Crippled have been described so often that a detailed consideration of the steps in technic is unnecessary here. In brief, since 1890, the great majority of cases of inguinal hernia have been operated upon by the Bassini method, with slight modifications described by Coley (William B.) in Keen's Surgery, 1908. With the exception of two or three cases operated upon in 1890, in which silk sutures were used, chromicized kangaroo tendon has been used for the buried sutures during the entire period. In direct hernia, a number of different methods or variations of technic have been employed at different times. At present we are inclined to favor the transplantation of the cord to a position superficial to the external oblique, as in the Halsted operation, with the overlapping of the external oblique aponeurosis as advocated by Champonniere and Andrews, and recently modified by Schley and Stetten. If this method be adopted, and in addition, fascial sutures (Gallie) be utilized, we believe that the results in these difficult cases will be very markedly improved.

Local Anæsthesia.—There is no doubt of the desirability of using local anæsthesia for strangulated hernia, where the patient's condition is apt to be such that the general anæsthetic may turn the balance against recovery. And it has widened the field of operability to include otherwise bad risks; the diabetic, the cardiac, the elderly patient. However, in children, and in most adults where a definite contra-indication does not exist, we prefer a general anæsthetic, generally gas-oxygen with a minimal amount of ether in adults, and drop ether by open cone method in children. The results are most satisfactory from the point of view of high ligation of the sac, tightness of closure, and duration of the operation. In short, though novocaine anæsthesia has a distinct and useful place in herniotomy, it has not become a routine procedure with us. Morrow states that he has used it for fifteen years as a routine measure, believing that in addition to its other advantages, it eliminates the recurrences that may be due to vomiting and straining during recovery from a general

anæsthetic. It has been our experience that, where gas and oxygen with a minimal amount of ether is used, post-operative emesis is not pronounced.

Mortality.—There were eleven deaths or a percentage mortality of 0.37. In ten cases, death occurred between the first and fifth post-operative days. The causes of death represent the usual surgical hazards. In only one instance was advanced age of significance; this patient being a male of eighty-one years, whose Bassini repair for double direct inguinal hernia had been performed under local anæsthesia, and who died of pulmonary embolus on the second post-operative day. The one case operated upon for strangulation was a huge umbilical hernia, and death which occurred on the table, was due to a combination of shock, toxæmia from ileus, and the general anæsthetic. The anæsthetic is the only factor which might better, perhaps, have been eliminated, substituting instead, local. As a general rule, strangulated hernia in adults should be dealt with under local anæsthesia.

SUMMARY

1. Three thousand consecutive recent herniotomies have been classified according to age, sex, and type of hernia. Recurrence rates in each group have been compiled, based on 837 cases actually followed up.

2. Causes of recurrence may be arbitrarily divided into: (a) Those factors which are inherent in the individual patients, *e.g.*, age, occupation, size and type of hernia, development of abdominal musculature, presence of adipose tissue, etc. The complete or partial absence of conjoined tendon is the main surgical problem that must be met. (b) Factors over which the surgeon has control, *e.g.*, failure to recognize and dispose of hernial sac, wound infection, use of non-absorbable suture material, closure under tension, failure to support operative wound by proper dressings, and to forestall post-operative bronchitis and pneumonia with their attendant cough by appropriate preventive measures, allowing the patient out of bed too soon, etc. The exercise of more careful judgment in selecting cases for operation, basing the decision on a consideration of the patient's possible factors of failure on the one hand, and more attention to the details of operative technic and post-operative care on the other, will tend to reduce recurrence rates.

3. Recurrence in children should be a rare sequel to a properly performed operation. In 1191 operations, for all varieties of hernia, 300 of which were followed, we have been unable to find a single recurrence.

4. Follow-up examinations of all cases is becoming the rule in most metropolitan clinics. It has been the rule in the Hospital for Ruptured and Crippled for thirty years. Recurrence rates not based upon a follow-up examination should be discounted.

5. Direct hernia is rare in the female and in children under fifteen years; three cases of the former, and four of the latter (all males) were found in this series. The cure of direct hernia represents a distinct problem. Many

THREE THOUSAND CONSECUTIVE HERNIOTOMIES

are best managed by some modification of the Bassini operation. A certain proportion present musculo-aponeurotic deficiencies which render the likelihood of a permanent cure slight, and in this group, operation should be withheld. In the exercise of more careful judgment in selecting cases for operation, as Morrow⁶ has stated, lies the hope for better end-results, rather than in the adoption of new procedures based upon new principles. "Saddle-bag" or direct and indirect hernia should be considered as a variety of direct hernia and so treated. Removal of both sacs is essential. Our series of 280 direct hernia in the male adult, of which, 85 cases have been followed, shows 14 recurrences or 16.4 per cent. The "living suture" repair of Gallie has a wide usefulness in this variety of hernia and may become the method of choice.

6. There is lacking, thus far, any conclusive evidence that femoral hernia repair by the inguinal route is productive of better results than have been obtained by the simpler method.

7. Cases that have once recurred will be more apt to recur again, and the second recurrence may be larger and less amenable to truss treatment; therefore, the question of re-operation should be most carefully considered, and in every case, it should not be advised. Thirteen per cent. of the fifty-seven recurrences in this series, had followed operation for previous recurrence. Gallie's operation, using "living sutures" has a distinct place in this group.

8. Consideration of the available tissues for repair should determine the type of operation to be used in each individual case. The use of a standardized technic for all cases is to be deprecated.

9. Local anæsthesia has extended the field of operability to include the aged and those suffering from intercurrent disease which, in itself, contraindicates the use of a general anæsthetic. It is strongly urged in cases of strangulated hernia in adults. However, as a routine, we favor for adults, gas-oxygen with the addition of a small amount of ether if necessary; and for children, ether by drop method and open cone.

10. We subscribe to Morrow's statement that many surgeons consider the operative cure of hernia a simple procedure, and agree with him that it requires sound surgical judgment and considerable technical skill.

The writer acknowledges the courtesy of Dr. John B. Walker and Dr. William B. Coley in permitting him the privilege of compiling these statistics based on the records of the First and Second Hernia Divisions of the Hospital for Ruptured and Crippled.

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THE SURGICAL ASPECTS OF XANTHOMA TUMORS

BY EDWIN M. MILLER, M.D.

OF CHICAGO, ILL

SINCE Rayer¹ in 1836 first described the yellow plaques of the eyelids, and Lebert² in 1845 mentioned a peculiar yellowish fatty substance found in certain tumors of the soft parts, xanthomatous lesions have given rise to many interesting studies by dermatologists, chemists, pathologists and in more recent years by surgeons. At the present time two well-defined clinical forms are

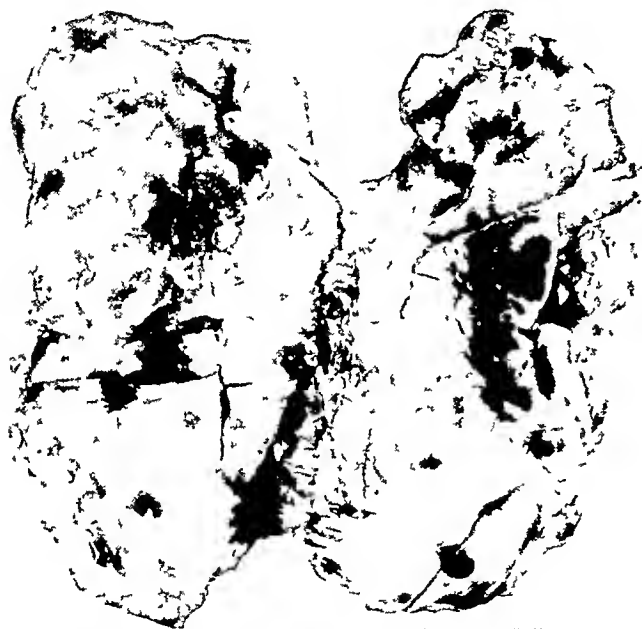


FIG 1.—Xanthoma of foot (Cross-section) This was a well encapsulated tumor arising from the flexor tendon sheaths, presenting a brilliant yellow-orange color on section.

recognized: (1) The so-called *xanthelasma*, a local lesion confined to the eyelids and (2) *xanthoma multiplex*, which is a generalized form manifesting itself by widespread cutaneous lesions. In addition there are solitary forms occurring as xanthomatous tumors, about which, as we shall see, there is considerable dispute as to classification.

Xanthelasma, the form most commonly met with, is characterized clinically by the presence of multiple, small, soft, yellowish,

chamois-like patches on the eyelids. They are often symmetrically arranged and appear as a rule near the inner canthus of the eye. They occur almost invariably in persons beyond middle life, develop slowly, are not associated with disease elsewhere in the body, and remain unchanged for many years. For the histology of these lesions we are especially indebted to Pollitzer and Wile³ and Waldeyer⁴ who have shown that they represent a degenerative process within the muscle tissue of the eyelid and appear histologically as an accumulation of large polyhedral foamy cells which have undergone a peculiar fatty degeneration.

Xanthoma multiplex, a form more rarely seen, but even more striking than the first, is a generalized manifestation of an eruptive disease, appearing cutaneously as yellowish lesions varying from papules, nodules and tubercles to flat infiltrated plaques or fine yellowish lines. They occur in small groups often symmetrically arranged or in large numbers, especially about the

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joints—the shoulders, elbows, hips and knees, but not uncommonly widely distributed over the trunk and extremities. It is met with particularly in young people and may even be congenital. A close study of these cutaneous lesions by many investigators since Virchow⁵ first described them as degenerated forms of a connective tissue neoplasm, has brought to light unmistakable evidence that they represent a connective tissue reaction toward a retained foreign material, and that they bear a definite relation to diseases of metabolism. Examination of early lesions by Pinkus and Pick,⁶ Pollitzer and Wile,⁷ Macleod⁸ and

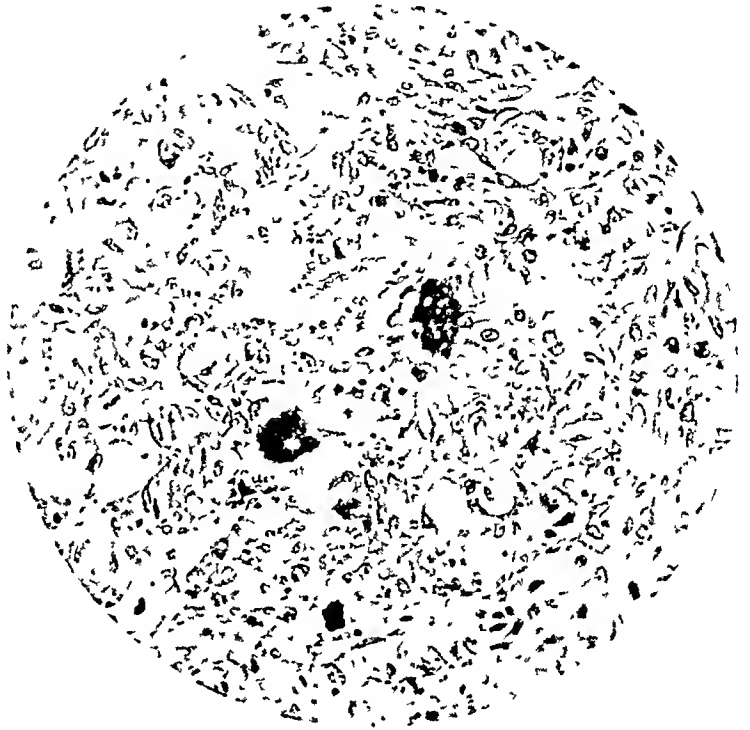


FIG. 2.—Xanthoma of the foot. Low power showing proliferation of fibrous connective tissue and large multinuclear foreign body giant cells. (Magnification 240 diameters.)

others has shown that the initial phase consists in a dilatation of the cutaneous capillaries, a proliferation of the perivascular endothelium and a deposit within the tissue spaces of a finely divided lipoid substance which in later stages is absorbed by the endothelial and connective tissue cells as a foreign material. This gives rise to the formation of large polyhedral cells with small nuclei and granular cytoplasm and is accompanied by a reaction on the part of the surrounding tissues resulting in the formation of large multinuclear foreign body giant cells and an active proliferation of the fibrous tissue. The frequent



FIG. 3.—Xanthoma of foot. High power view showing typical "foam" cells. (Magnification 1200 diameters.)

proximity of these lesions to the joints is explained on the basis of increased intracapillary tension resulting from constant mobility of the tissues. The exact nature of this lipoid substance giving rise to these lesions has been the object of many studies, and has been definitely identified by Pinkus and Pick,⁹ Pringsheim,¹⁰ Pollitzer and Wile,¹¹ Darier,¹² Burns,¹³ Smith¹⁴ and many others. It consists of a cholesterol fatty acid ester which is doubly refractive to polarized light. In fresh tissues fixed in formalin the lipoid granules appear as small yellow-red globules when stained with sudan



FIG. 4.—Picture made six months after removal of xanthoma tumor (Case I). There is no evidence of recurrence.

III, and assume a gray color with osmic acid. When fixed in alcohol they are readily dissolved, and leave behind small vacuoles which appear microscopically like foam, and have given rise in the literature to the term "foam cells" or "xanthoma cells." The detection of this lipoid and the close association of xanthoma multiplex with jaundice and diabetes have been the stimulus for a vast amount of research devoted to the solution of the fundamental chemical problems concerned. While a critical review of this work is not essential to the subject under discussion, yet a brief summary of the main features

seems necessary before we may have a clear perception of the meaning of xanthomatous tissues in the forms in which surgeons most commonly see them.

Cholesterin, an integral part of all body tissues, exists normally in the blood serum in a concentration of about .16 per cent. It is derived partly from the food, but mainly from the internal secretions of the various tissues. It is eliminated through the bile either in the normal state or in the form of cholalic acid. It is increased physiologically during menstruation, pregnancy, and in the puerperal state, and to its presence has been attributed the severe vomiting during the early months of the child-bearing period. Its characteristic large flat crystals may be found in any tissue in which cells are undergoing slow destruction and where absorption is poor, as in atheromatous patches of the

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blood-vessels, encapsulated caseous areas, old infarcts or hæmatomas. Its ratio in the blood is markedly increased in Bright's disease and particularly in icteric conditions due to obstruction to its normal channel of elimination—the common bile duct.

According to Wells¹⁵ *fat* in body tissues is derived (1) from food and (2) from carbohydrates by a synthetic process. If from proteins at all it is probably due to the presence within them of carbohydrate groups. It is utilized and transported in the form of its two primary constituents, fatty acids and glycerol. It enters and leaves

the cell in this condition, being split or combined by the action of the tissue lipase. Normally there is little visible fat in the cells of the parenchymatous organs because they are constantly being used up by the oxidation of the glycerol and fatty acids by the intracellular oxidases. Where there is abundant lipase and little oxidative activity, as in the areolar tissues and liver, fat accumulates in large amounts. In a true fatty infiltration, which is dependent upon decreased oxidation, the fat



FIG. 5.—Case II. Cystosarcoma-phylloides of the breast.

accumulates within the cells as a single large droplet; whereas in a true fatty degeneration, which is brought about by poisons, the fat droplets lie well distributed in the granular debris. The accumulation of fat in dead tissue such as an anemic infarct, is due to the action of the cell lipase upon the fatty acids and glycerol which are diffused in from the periphery into an area deprived of oxygen. The amount of fat actually present in a tissue cannot be accurately judged by the histological appearance of the fat within the cells, because a certain portion of the fat is held in such firm combination that it cannot be demonstrated by staining methods. This fixed material is not simple fat, but lecithin and cholesterol compounds. In 1902, Kaiserling and Orgler¹⁶ described under the name "Myelin" certain intracellular droplets that may be found in the adrenal cortex, in amyloid kidneys, pneumonic exudates, tumor cells, retrogressive thymus tissue, corpus luteum, and atheromatous patches of arteries. This material differs from ordinary fat in being doubly refractive (anisotropic) when viewed with the Nicoll prisms and in staining but slightly gray with osmic acid. These myelins, according to Wells, are probably mixtures of lipoids in which cholesterol esters are very prominent. This work

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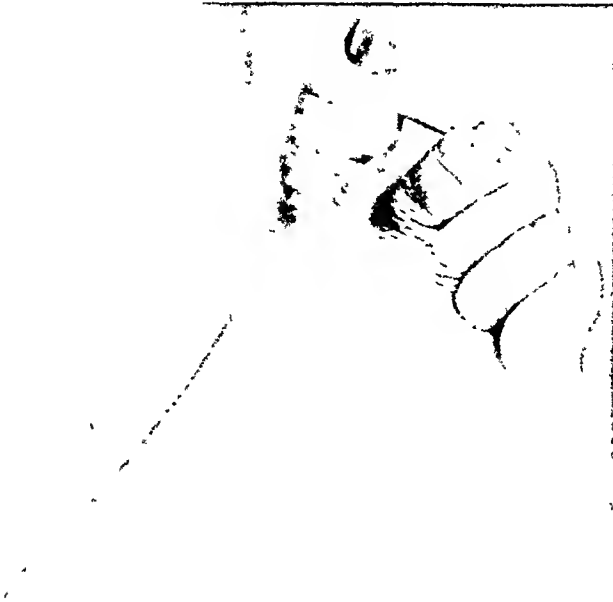


FIG. 4 —Picture made six months after removal of xanthoma tumor (Case I). There is no evidence of recurrence.

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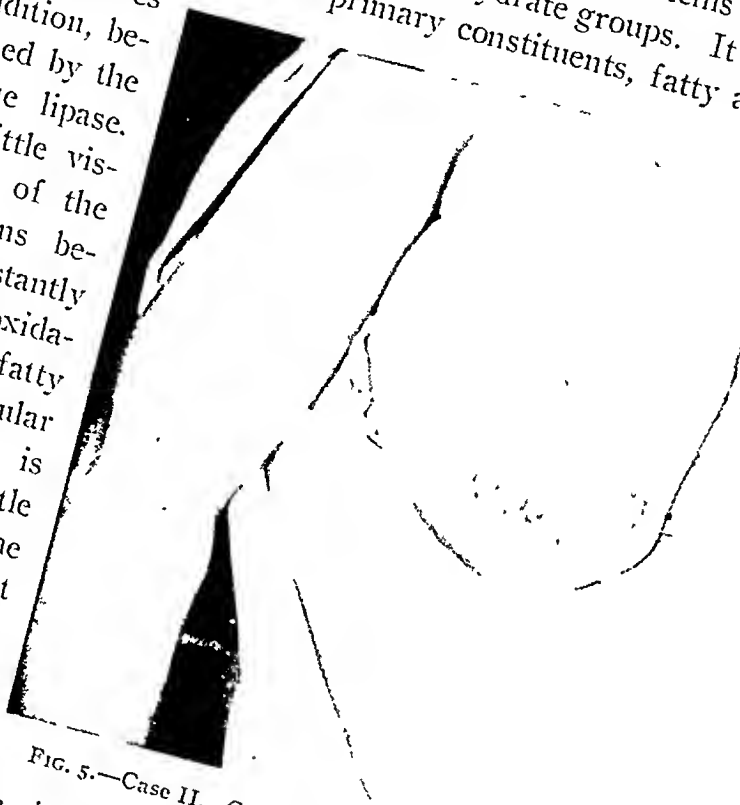


FIG. 5.—Case II. Cystosarcoma-phyllodes of the breast.

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has been corroborated by Dunin-Karwicka¹⁷ who has shown that this same material is found in the cortical cells of the adrenal gland, lutein cells of the ovary, and is seen pathologically in the atheromatous arteries, actinomyces, chronic inflammatory areas, and is the chief constituent of hypernephromas and xanthomatous tumors.

In view then of the conditions under which cholesterol esters are found



FIG 6.—Cystosarcoma-phylloides, (Case II). Cross-section of the tumor showing the yellow area A of xanthoma tissue. This tumor was in all respects benign.

in the body it is only reasonable to suppose that xanthomatous tissue may not only be widely distributed, but would be most abundantly found in diseases associated with a lipemia or a hypercholesterinemia, and this supposition is readily confirmed by clinical observation. Diabetes mellitus, as is well known, is almost invariably accompanied by a lipemia and with it we often see generalized xanthomatous lesions. Mook and Weiss¹⁸ have recently reported three cases of generalized xanthoma associated with diabetes and two with a hypercholesterinemia. Rosenbloom¹⁹ in 1913 and Burns²⁰ in 1920 made determinations by the Bloor method, the latter finding three times the normal cholesterol content of the blood in xanthoma multiplex. Similar findings have been reported by Yamaoka and Kashuabara.²¹ Pinkus and Pick²² have studied symmetrical xanthoma lesions in a patient intensely jaundiced and Kaposi²³ has stated that 56 per cent. of the generalized forms of xanthoma are associated with icterus. Perhaps the most interesting and instructive report, however, has recently come from Weidman and Freeman²⁴ who observed widespread xanthomatous lesions of the internal organs and an extreme cutaneous involvement in a boy who had died after a long-continued jaundice. The seat of the original trouble was a biliary cirrhosis, which in turn had led to a hypercholesterinemia and consequent xanthomatous changes in the tissues. The hilum of the liver, the interstitial tissue of the lung alveoli

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the bones of the cranium, the meninges and stalk of the hypophysis all showed histologically the typical foam cells, foreign body giant cells and grossly had the brilliant yellow color which are characteristic of xanthoma lesions.

In view of the fact, that, except when associated with a hypercholesterinemia or a lipemia, the presence of xanthomatous tissue is indicative of a degenerative process peculiar to endothelial or connective tissue cells, it is quite evident that a consideration of xanthomatous tumors from the surgical point of view, must necessarily be confined to those in which one or both of these types of cell predominate. In the literature there has been much difference of opinion regarding these tumors and not a little confusion as to their classification, being spoken of as myelomas, endotheliomas, angiomas, giant-celled tumors, xanthomas, or combinations of these terms.



FIG. 7.—Cystosarcoma-phylloides, with xanthomatous degeneration of the connective tissue stroma. Lower power view, Case II. (Magnification 70 diameters.)



FIG. 8.—Cystosarcoma-phylloides, Case II. Low power showing groups of "foam" cells, A.

As far back as 1845 Lebert in his "physiologic pathologique" in describing certain fibro-plastique tumors speaks of their yellow color and the presence within them of a peculiar fat which he called "xanthos." Sir James Paget²² in 1856 in his "Surgical Pathology" refers to myeloid tumors of the mammary gland, eyelids, conjunctiva, subcutaneous tissues and bone, in which he found large multinucleated giant cells. Heurtaux²³ of Nantes, in a classical monograph in 1891 first described myelomas of the tendon sheaths, report-

ing three cases, and classed them with benign tumors. All three presented a yellow color in certain areas and within the tissues an ether soluble fatty substance was found. Dor²⁷ in 1898 called them myelo-xanthomas and expressed the belief that the xanthoma cells and the multinuclear giant cells had the same origin. Bellamy²⁸ in 1901 classed them as endotheliomas, inasmuch as in the evolution of the tumor the primary phase is a proliferation of the endothelial cells of the blood-vessels. Bloodgood²⁹ in 1903 and again in 1905³⁰ classified them among the benign hæmangiomas. Tourneux³¹ in 1913 collected from the literature and from personal observation 93 cases of what he called

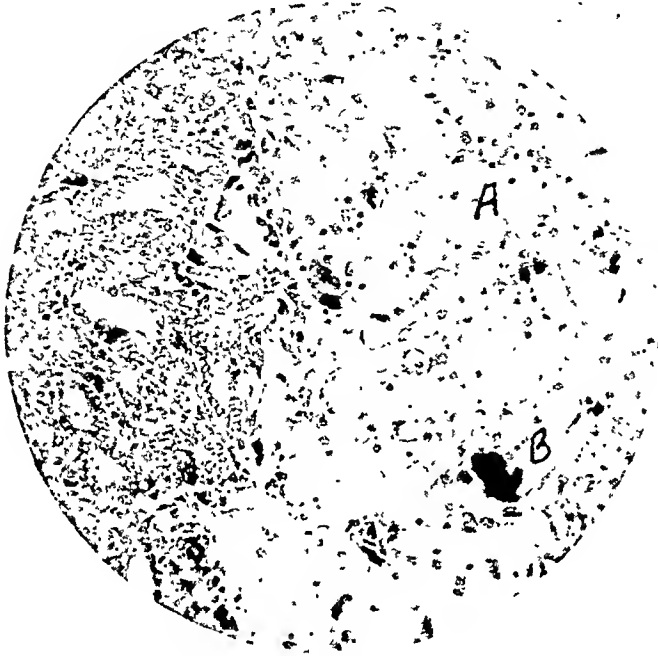


FIG. 9.—Case II, Cystosarcoma-phyllodes. Higher power, showing "foam" cells, A and a foreign body giant cell, B. (Magnification 240 diameters.)

xanthosarcomas of the tendon sheaths in which 54 were of the xanthoma type. The finger was the site of the lesion in 48, the hand in 12, forearm in 6, foot in 19, and the leg in 1. He states that they may grow very slowly and be stationary for years, and then suddenly grow rapidly, or may be malignant from the start. Those in the fingers seem to be most benign. In 21 there was recurrence after local removal. Landois and Reid³² in 1915 described the foam cells and giant cells in a xanthoma which had been mistaken for a sarcoma, and expressed the belief that they were not pathognomonic of xanthoma and were due to absorption of cholesterol from the broken-down blood cells.

Broders³³ of the Mayo Clinic in 1919 reported 17 cases of benign xanthic extra-periosteal tumors of the extremities of which 16 were connected with a tendon sheath. Foreign body giant cells and blood pigment were present in all of his cases and foam cells in 64 per cent. In 35.3 per cent. the etiology was associated with a definite history of injury. Ollerenshaw³⁴ in 1922 described bilateral symmetrical tumors of the Achilles tendon the size of walnuts which were removed at operation. They contained many giant cells and foam cells and he called them granulomas. In addition to the local tumors cutaneous xanthomatous lesions existed on the arms. Fleissig³⁵ in 1922, after reporting 3 cases of his own and reviewing many cases from the literature came to the conclusion that the so-called "myelomas" or "giant-celled sarcomas" of the tendon sheaths of the fingers, toes, hands and feet, forearms and legs, are not true tumors at all, but tendon sheath granulomas. They are all somewhat lobulated, have a yellow-red mottled color, and are of a firm elastic consistency. Microscopically there is a conspicuous absence of sarcoma tissue, a predominance of foreign body giant cells, and the blood pigment present in the tissue has nothing to do with the color of the tumor. They are benign and local removal is sufficient.

These views correspond in the main with those of Garrett,³⁶ who working in Bloodgood's laboratory, has very recently published a careful study of 196 soft tissue tumors. These included 76 fibrohæmangiomas, 30 fibromas of the tendon sheaths, 26

granulation tissue tumors, 53 cases of bursitis, and 11 tumors connected with joints. In this series the characteristic elements of xanthoma tissue, namely the yellow color, the foam cells, and the foreign body giant cells, could be made out in 19 of the fibro-hæmangiomas, in 11 of the tendon sheath fibromas, in one granulation tissue tumor, in 2 bursitis cases, and in 4 tumors connected with joints. The author differs with Fleissig in believing that the yellow color of these tumors is due entirely to pigment absorbed from the degenerated blood, lays particular stress upon their benign character, but at the same time strongly emphasizes the importance of thorough local removal.

While it is true that the majority of xanthomatous tumors are seen about the hands and feet, especially in connection with the tendon sheaths, other parts of the body are not infrequently involved. Thus Carroll Smith³⁷ in describing what he calls

"true xanthoma tumors,"

reports one situated on the tongue, one on the labia majora involving the skin and submucosa, a third in the parotid gland and a fourth, a walnut sized tumor, in the dura over the region of the frontal lobe. All of these were benign tumors and were classed as xanthomatous endotheliomas. Of even greater interest is the report of Ewing³⁸ who in 1922 described typical xanthomatous tissue in connection with tumors of bone. "Some of the central giant-cell tumors of

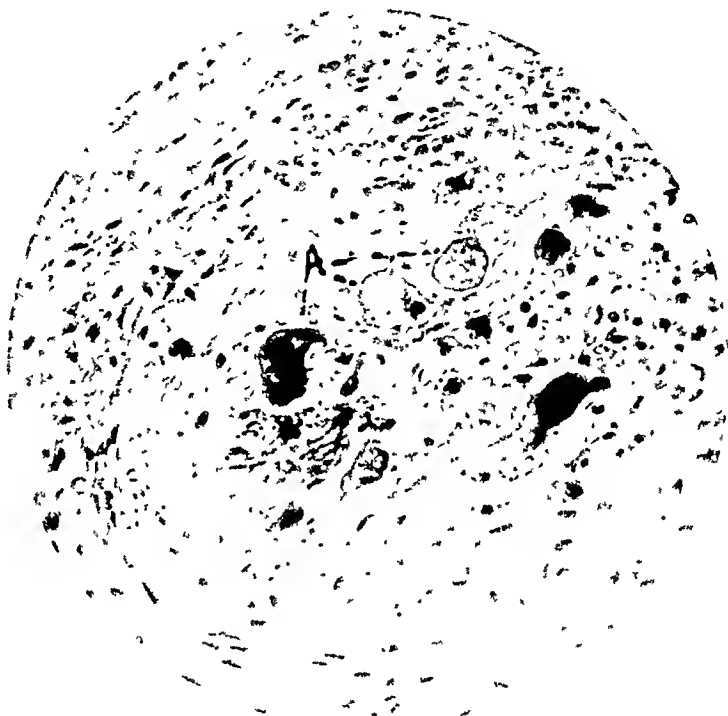


FIG. 10.—Case II, cystosarcoma-phyllodes. Higher power, showing a group of multinuclear foreign body giant cells, A. (Magnification 240 diameters.)

bone" he says, "are solid throughout, firm, dry and yellow. The yellow color is due to the presence of many large polyhedral cells distended with lipid granules. These tumors have greater growth capacity than the ordinary giant-cell tumor. They often reach considerable size, breaking down the bony capsule and forcing their way between muscle and fascia, but definite infiltrative growth is rare. . . . Their structure presents a diffuse growth of medium sized spindle cells with very little hyperchromatism. Varying proportions of the tissue are composed of the lipid cells. Giant cells are missing over large portions of the growth, but usually they appear abundantly in some portions, generally about blood spaces or blood extravasations. If the histologist encounters only the spindle cells, an erroneous impression of a malignant tumor is liable to be gained. . . . I have never known these tumors to produce metastases and I have been unable to find authentic records of such complication, but it seems quite possible that by curettage, groups of viable cells

could be dislodged from the tumor mass and pass into the blood-vessels. However, the blood-vessels are usually small and scanty and the danger of metastases can probably be ignored. That a central xanthosarcoma of bone is a variant of the giant-cell tumor is clearly indicated by the clinical history, central location, general structure, the course of the growth as revealed by the X-ray, and by the not infrequent occurrence of xanthoma cells in typical giant-cell tumors."

One might go on indefinitely and cite reports from other authors, without adding materially to the evidence already at hand that xanthomatous changes being of a degenerative character may occur in any type of endothelial or connective-tissue tumor in which the metabolic disturbances are favorable for

their formation, and that by far the majority of tumors in which xanthomatous tissue is seen are benign in character and should be so surgically treated.

The author desires to present three clinical cases in which xanthomatous changes are well illustrated. The *first* is that of a Jewish woman about fifty years of age who came to the hospital because of tumor of the right foot which had been developing for the past two years. When first noticed it was a small pea-sized nodule on the dorsum of the foot; it grew rapidly to the size of a cherry and then very slowly enlarged until it has now become the size of a walnut. There was

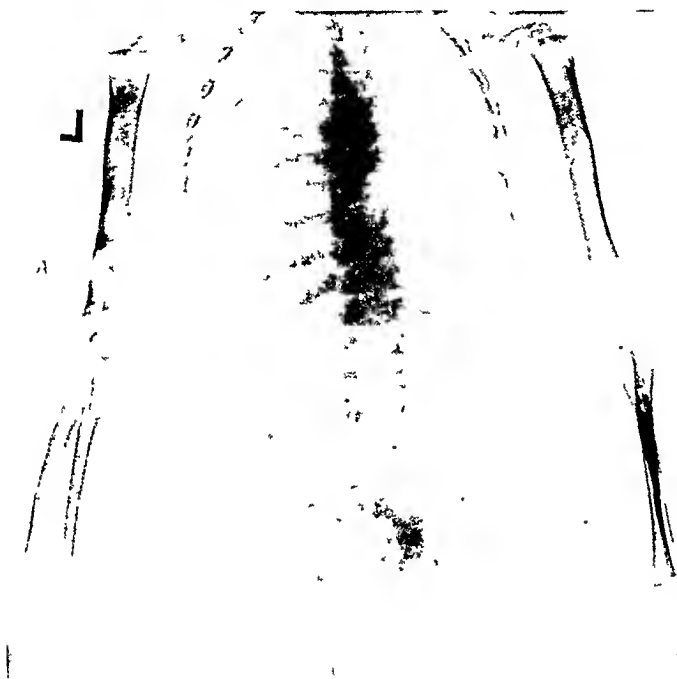


FIG. 11.—Multiple myelomas. At A, tissue was removed for microscopic section and showed typical xanthoma cells.

no injury associated with its onset, it was at no time painful, and the only reason for her coming to the doctor was the inconvenience it gave her in walking. On examination we found a non-inflammatory rather firmly fixed solid tumor the size and shape of half an egg with its broad base occupying the area over the web between the great and second toes. Its surface was smooth and the skin over it could be wrinkled between the fingers. X-ray showed no calcification and no bony abnormalities and we made a diagnosis of a benign, well encapsulated connective tissue tumor, probably a fibroma. Under local anæsthesia a longitudinal incision was made over the tumor and a definite line of cleavage followed between the skin and the fibrous capsule of the tumor. The separation was continued without difficulty down to the web between the toes where an indefinite connection with the sheath of the flexor tendons was divided and the tumor removed intact. On cutting through the tumor with a knife the tissue though fairly firm had an elastic spongy consistency, and the cut surface was of a diffuse brilliant yellow-orange color mottled with small areas of reddish-brown. (Fig. 1.) Microscopic examination (Fig. 2) showed a ground work of loose fibrous connective tissue rich in blood-vessels with clusters of

large polyhedral cells scattered diffusely throughout the tumor. Many large multinuclear foreign body giant cells were seen, and not a little yellow pigment. Under high power (Fig. 3) these large polyhedral cells were seen to have rather small dark nuclei, and the cytoplasm to be filled with fine granules which gave a yellow-red color with sudan III. and a gray color with osmic acid, the typical picture of the foam cells characteristic of xanthoma tumors. Repair of the wound was rapid and there has been no evidence of recurrence 6 months after operation (Fig. 4).

The *second* case is that of a woman of forty years, who entered the service of Doctor Lewis because of a tumor of the right breast which had been gradually developing over a period of 6 years, not associated with pain, glandular enlargement or discharge from the nipple. (Fig. 5.) Examination showed a tumor mass about the size and shape of a grape fruit occupying the anterior part of the breast. It had a peculiar violaceous color, was solid in consistency, presented a smooth surface and was freely movable over the pectoral muscles. A diagnosis of cystosarcoma-phyllodes was made and this was confirmed by operation which consisted of a complete mastectomy. On cross-section of the tumor (Fig. 6) an area about the size of a hen's egg had a brilliant yellow-orange color which was in marked contrast to the remaining tissue. On microscopic section (Figs. 7, 8, 9 and 10) through this area the connective-tissue stroma of the long tree-like processes showed a large amount of blood pigment, many large multinuclear foreign body giant cells, and the typical foam cells of xanthoma tissue. This is a very unusual finding in a breast tumor and without doubt represents a degenerative process in the connective tissue in a rather limited portion of a large benign tumor.

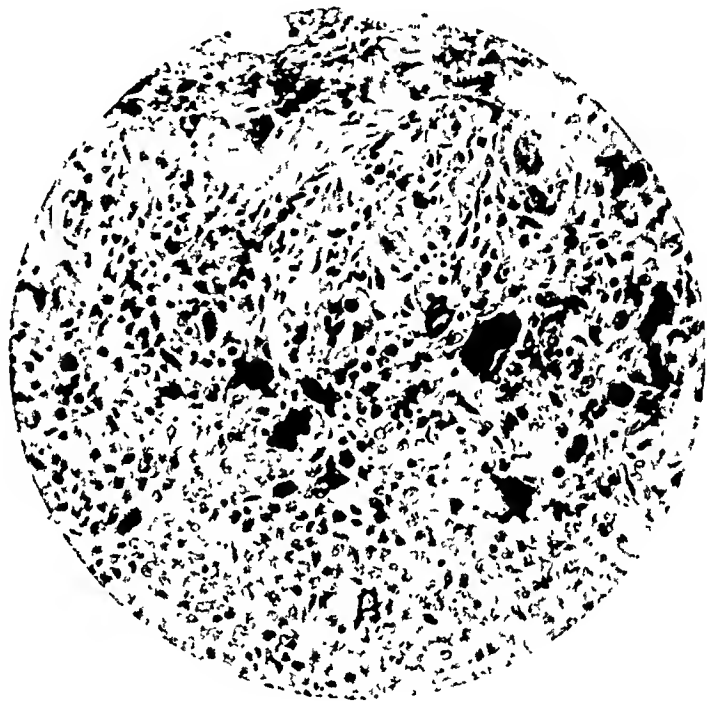


FIG. 12.—Multiple myelomas, Case III. Showing myeloid cells A and multinuclear giant cells B. (Magnification 250 diameters.)

The *third* case is that of a small boy who entered the service of Doctor Phemister with multiple myelomas involving the bones of the cranium, vertebrae and extremities. (Fig. 11.) For the purpose of microscopic study a piece of tissue was removed from a lesion in the shaft of the humerus. The predominating type of cells was the plasma cells and myelocytes, but in addition there were areas near the cortical bone in which large multinuclear foreign body giant cells were seen (Fig. 12) and in a few places the typical foam cells characteristic of xanthoma tissue were present (Fig. 13).

While these clinical reports add weight to the already well established views regarding the nature of xanthomatous tissue, there still remains the much disputed question as to what the yellow color of this tissue is due. Bloodgood and his students have attributed it to the presence of blood pigment, while Fleissig has emphatically expressed his belief that this is a negligible factor and that the real cause is the presence in the foam cells of the lipoid granules.

The ideas of most other writers have coincided with one or the other of these two views. The true solution in all probability lies between the two, that is, a combination of both. Prof. Le Roy Palmer³⁰ of the University of Minnesota has during the past few years made exhaustive studies of the pigments in plant and animal life, and certain facts established by him have a direct bearing on the point under discussion. He has shown that the orange, red and yellow pigments found throughout plant and animal life are the carotinoids, carotin and xanthophyll. Certain animals, such as the swine, sheep, goats, dogs, cats and guinea pigs, whose body fat is white, are devoid of these pigments in their blood. The carotin of butter fat, adipose tissue and blood serum of cattle

is biologically derived from the food and that a similar relationship exists between xanthophyll of egg yolk and fowl tissue fat and plant xanthophyll. The pigments of human milk fat and probably human tissues in general very likely contain either of these pigments or both, and that there is evidence of a carotin albumen complex in the blood serum which may play an important part in the process of fat synthesis.

In the light of these facts there is little doubt

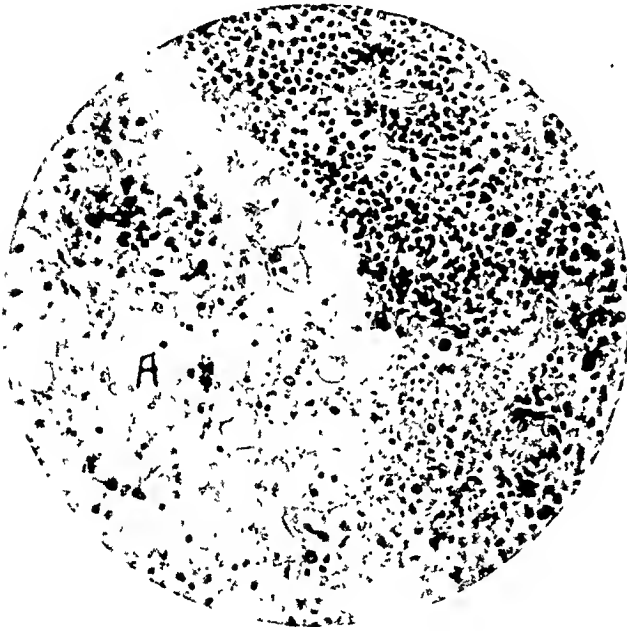


FIG. 13.—Case III. Multiple myelomas. Showing group of xanthoma "foam" cells A. (Magnification 250 diameters.)

but that the brilliant orange-yellow color of xanthoma tissue is directly due to the presence of one or both of these pigments, which being normally present in the blood serum are, as pointed out by Wells, readily taken up and combined with the cholesterol fatty acid esters (themselves colorless) which in all xanthoma tissues are so abundantly present.

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